MODERN PLASTICS

EPTEMBER 1961

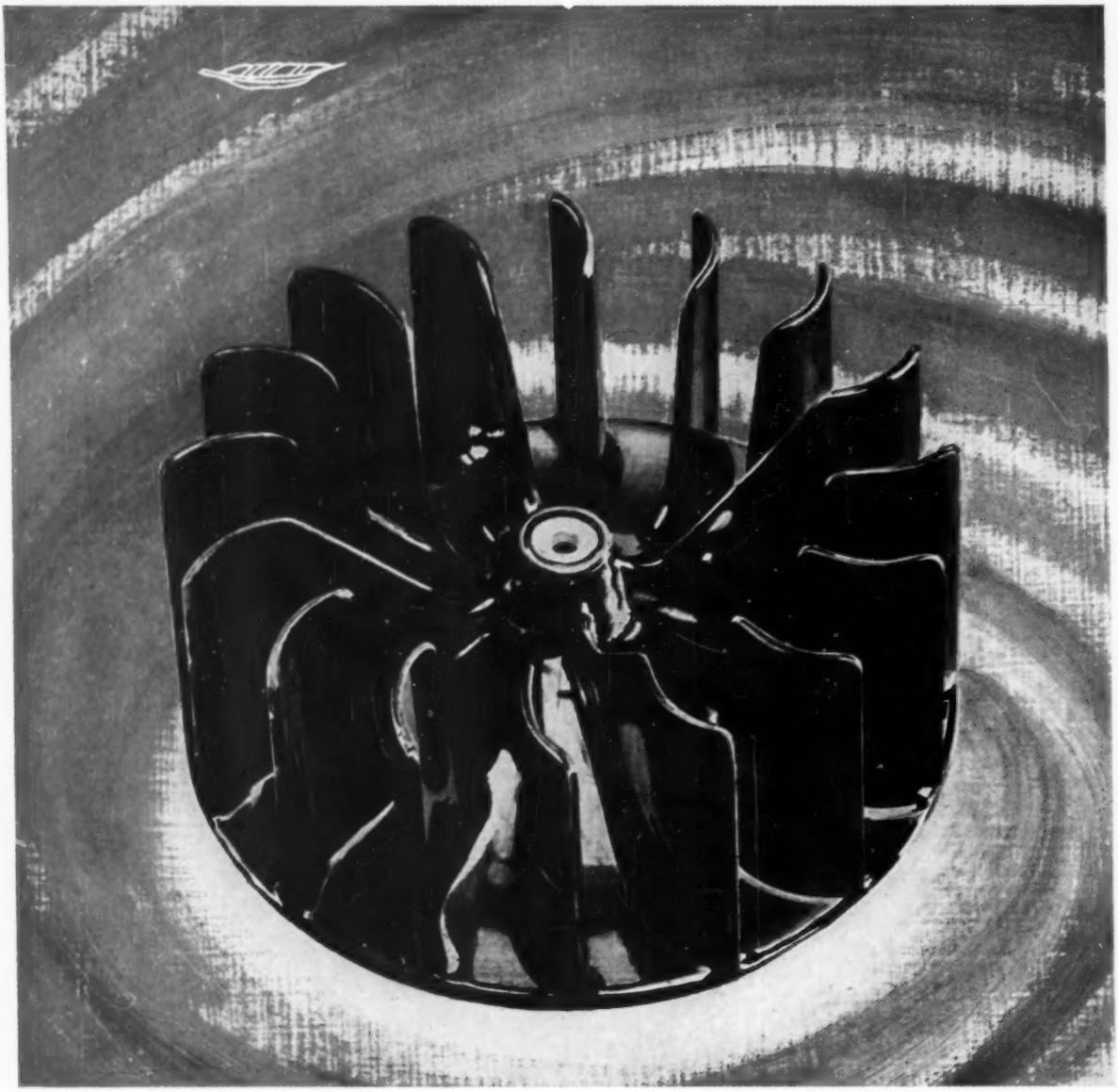
BAKE A PICTURE WITH POLYETHYLENE
p. 100

Progress in spray-up
p. 88

Molding vs. casting in encapsulation
p. 109

Plasticizer market in review
p. 165

One of a series directed to IDEA-MEN



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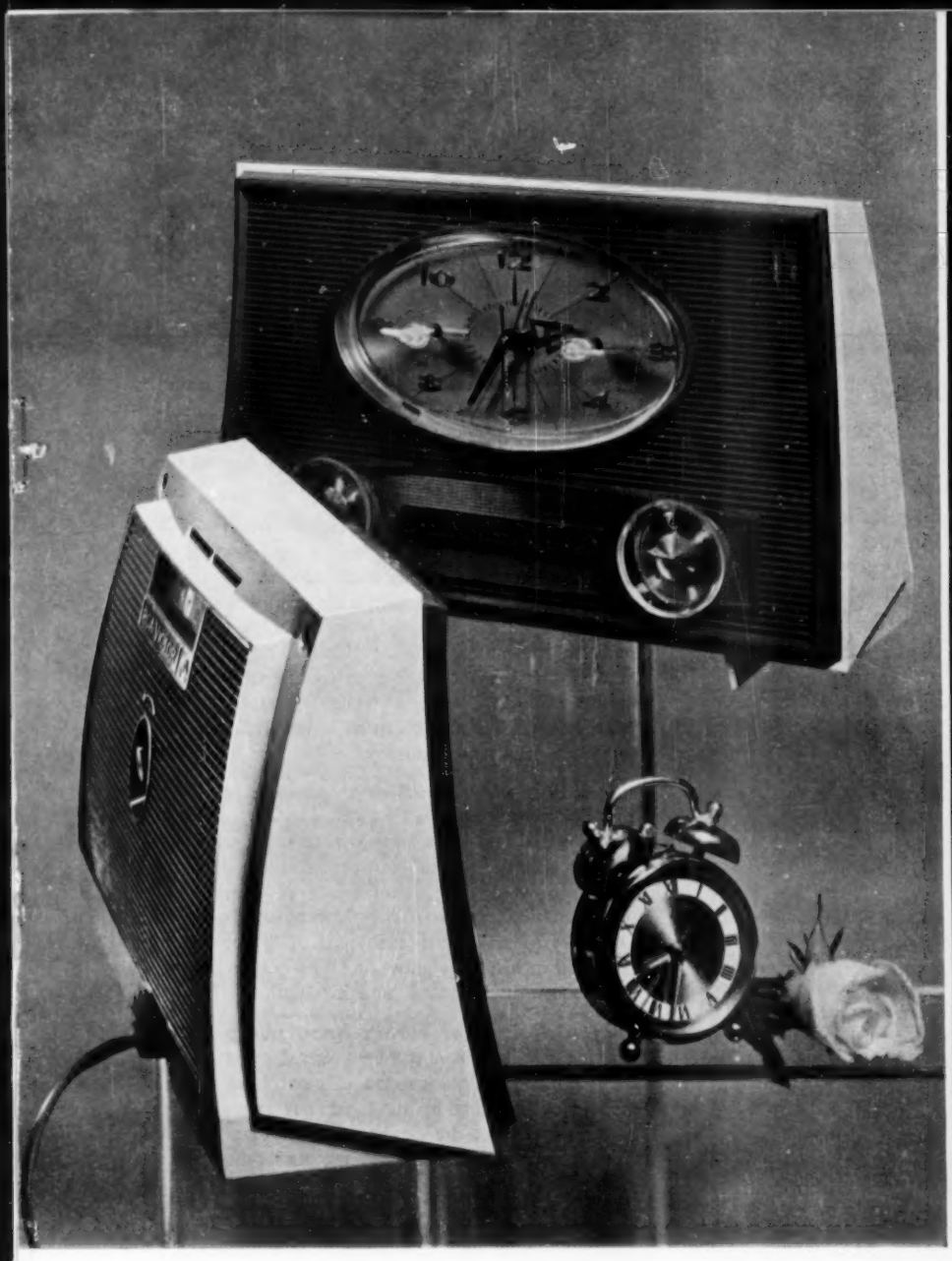

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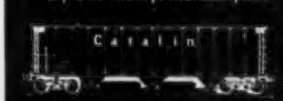

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MODERN PLASTICS

Volume 39, Number 1 **September 1961**

• THE PLASTISCOPE

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• EDITORIAL

Twenty-five years of technical leadership **87**

Since 1936, the Technical Section of MODERN PLASTICS has published over 620 articles that have gone into the permanent technical literature. Many of them were first announcements of new materials and processing methods.

• GENERAL

Progress in spray-up **88**

The spray-up segment of the U. S. reinforced plastics industry since its birth a few years ago has grown to over 750 spray-up depositor guns which this year may account for a 10-million-lb. laminate market. In this progress report the economics of this system vs. the more conventional RP techniques are analyzed, the markets defined, and the available machinery summarized. New developments in resins and reinforcements are also covered.

A tough case **93**

To provide rugged protection on the outside and gentle cushioning on the inside, a manufacturer of postage metering devices specified injection-molded ABS outer shells and expandable polystyrene beads foamed against a vacuum-formed inner liner for the carrying cases for his product.

First one-piece molded PP chairs moving fast **94**

Following three years of intensive development work, West Coast molder has now introduced the first line of polypropylene chairs in this country. Average weight per chair—which is produced in one shot—is 3.5 pounds; and the 1962 sales forecast anticipates a volume of 1 million units.

Precision parts mass produced **96**

Judicious material selection, sound processing techniques, and firm standards of quality control have enabled a pen manufacturer to maintain a position of leadership in a field that poses exacting engineering requirements. This article discloses the factors entering upon material selection decisions and divulges processing technique know-how.

Bake a picture with PE **100**

This month's cover illustration is a reproduction of a painting done in a completely new medium and by a completely new technique. Instead of oils and brushes, the artist's tools were finely powdered polyethylene and an ordinary kitchen broiler. This new art form is available both to the professional and the Sunday "do-it-yourselfer"; and may also have important implications as a decorating technique in the plastics industry.

Humidifier uses 7 different plastics in 17 components **103**

Sophisticated end-users have learned to be selective in their specification of plastics materials. A good case in point is this manufacturer of humidifiers who went the gamut from polypropylene to polyester film to make sure each part of his unit was produced in just the right resin. Why each material was chosen is presented here in detail.

Unique design for rotary hand pump **104**

Acrylonitrile-butadiene-styrene, acetal, and vinyl are combined to produce an efficient boat pump capable of handling up to 4 gal. per minute. An unusual aspect in the design of this pump is the fact that acetal parts bear against each other.

The Plasticizer market in review **165**

A definitive analysis of what happened to plasticizer production and sales in 1960, plus a run-down on how much of the various types were produced, what their most important end use markets are, and how the future is shaping up for them.
By William J. Reid

Nuclear weapons training aids **174**

How the U. S. Army makes use of acrylics, epoxies, and vinyl to produce teaching devices at significant savings over other materials.
By Arthur M. Ayvazian

New Developments **179**

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cameras (p. 181); . . . PE switch box protectors . . . New laminate for printed circuits . . . Impact acrylic patty maker . . . Butyrate men aid radiation studies (p. 182); . . . PP trap door for transistor radio . . . Product design with custom extrusions (p. 187); . . . RP totem pole display . . . UV protection (p. 191).

• ENGINEERING SECTION

Molding vs. casting for epoxy encapsulation **109**
For some electrical applications transfer molding techniques can mean additional profits.
By Gerard B. Rugg

New light on melt elasticity **116**
A rigorous analysis of the elastic recovery characteristics of branch and linear polyolefin melts. Examples of fabrication processes are cited where this property is an important factor for the precise control of final dimensions of fabricated items.
By Robert A. McCord and Bryce Maxwell

• TECHNICAL SECTION

Twenty-five years of progress in plastics **139**
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Thermal properties of reinforced plastics **140**
Specific heat, thermal expansion, and thermal conductivity were determined for 12 different resin-reinforcement combinations and one foam core over the temperature range —50 to 700° F.
By Paul T. Howse, Jr. and C. D. Pears

Stress distribution in the resin of reinforced plastics **154**
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By J. O. Outwater and D. C. West

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• Coming up . . .

The rapidly expanding urethane foam segment of the plastics industry comes in for thorough review in our October lead, including new formulations, advanced processing technology, and new markets . . . Cover article will present the first non-military applications of filament-wound structures, indicate the market potential . . . Polyethylene in radiation shielding . . . Part II of our polypropylene series, this one dealing with applications . . . Rotationally molded PE . . . Technical lead: Formulating chemically blown plastisol foam . . . Also in the works: Corrugated vinyl sheet for filtration . . . Massive acrylic castings . . . Bonding and printing of polyethylene film . . . Plastics in 1962 car.

The index to Vol. 38 of MODERN PLASTICS (Sept. '60—Aug. '61) is now available gratis to subscribers who request it. Address Readers' Service Dept., MODERN PLASTICS, 770 Lexington Ave., New York 21, N. Y.

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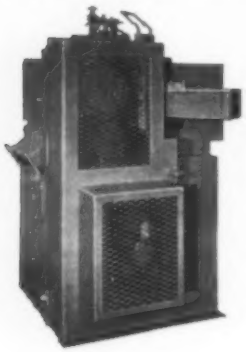

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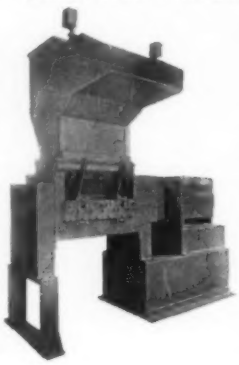

A large heavy-duty machine for extremely rugged work, offered in throat sizes 11"x30" and 16" x 30". Optional number of knives on rotor and optional type of knife mountings. Pivoted doors provide ready access to cutting chamber for easy cleaning and adjusting knives. Screen is readily removable.

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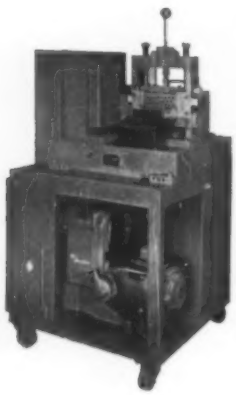

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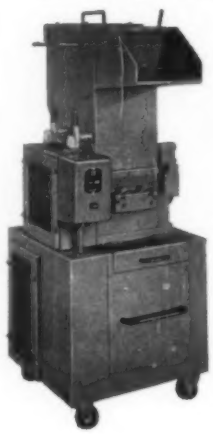
Five Improved Cumberland Large Throat Granulating Machines



Large throat openings – 8"x10", 10"x12", 10"x16" 14"x16", 14"x20" — designed for use beside the press or for central granulating machines.

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Granulating Machines O and 810

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Physical properties of one of the Abson extrusion land molding compounds (Abson 89001)

Specific gravity	1.06
Hardness (Rockwell R)	90
Tensile strength (psi)	4300
Impact strength (Izod—ft. lbs. per inch notch)	5 to 7
Flexural strength (psi)	8000
Compressive strength (psi)	5900
Heat distortion (at 264 psi—°F)	205
Elongation at break (%)	80

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Physical properties of an Estane polymer (Estane 5740x1)

Specific gravity	1.21
Hardness (Durometer A)	88
Tensile strength (psi)	5800
300% modulus	1200
Ultimate elongation	540
Graves tear (lbs. per inch)	430
Moisture vapor transmission (gms/100 in 2/24 hrs.)	26.3
Abrasion resistance	Excellent
Low-temperature properties	Superior
Gamma radiation resistance	Excellent

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Physical properties of typical Geon vinyls
A Rigid Compound (Geon 8700-A)

Specific gravity	1.35
Hardness (Durometer D)	78
Tensile strength (psi)	6200
Impact strength (Izod—ft. lbs. per inch notch)	15
Flexural strength (psi)	11,500
Compressive strength (psi)	8600
Heat distortion (at 264 psi—F°)	157

HI-TEMP GEON™

hi-temp Geon offers the advantages of vinyl but performs at 215°F, 60°F higher than the operating temperatures of previous rigid vinyls. This new addition to the Geon vinyl family can be used in the same way as any of the other uses of Geon — for extrusion, molding and calendering.

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Physical properties of hi-temp Geon high-impact compound (Geon 88805)

Specific gravity	1.5
Hardness (Rockwell R)	117
Tensile strength (psi)	7800
Impact strength (Izod—ft. lbs. per inch notch)	5
Flexural strength (psi)	14,500
Heat distortion (at 264 psi—F°)	215
Elongation at break (%)	4.5

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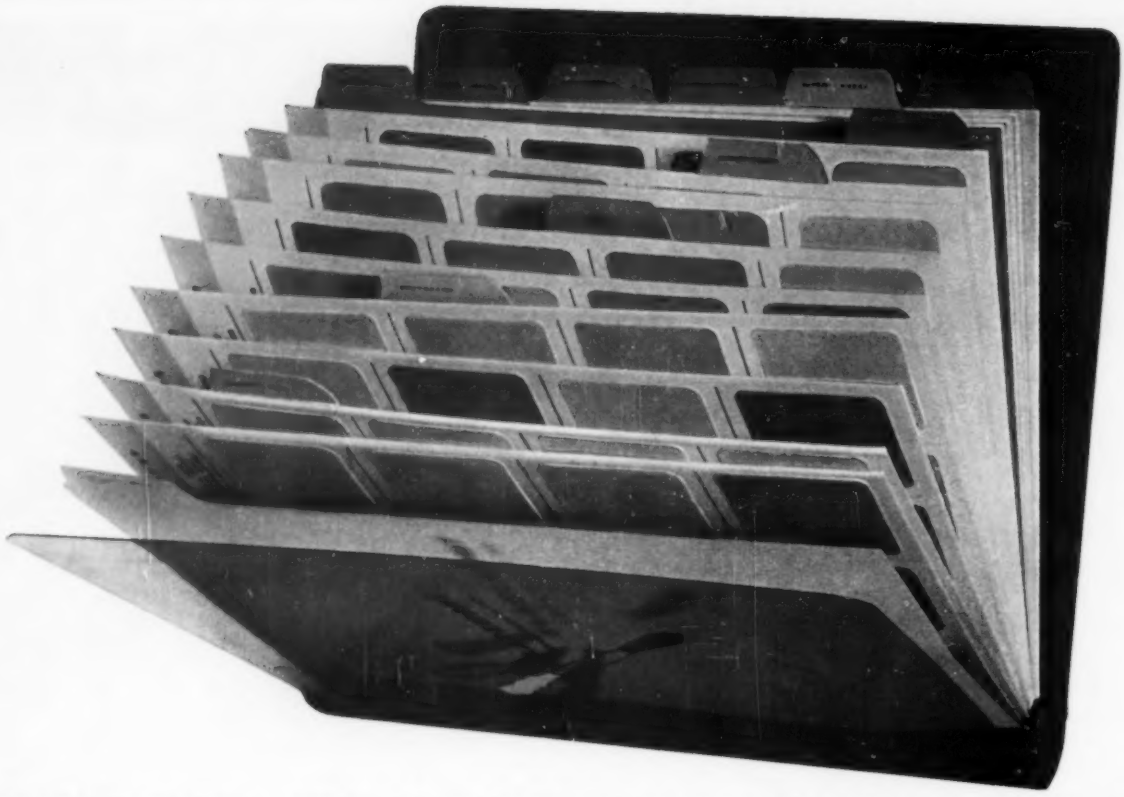

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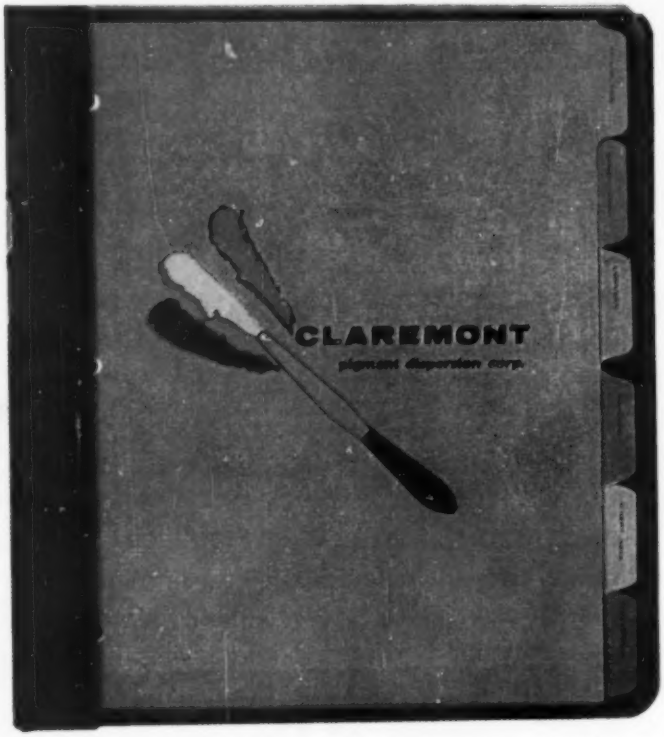

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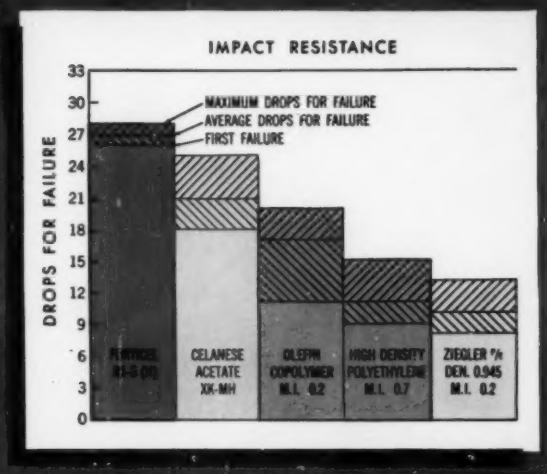

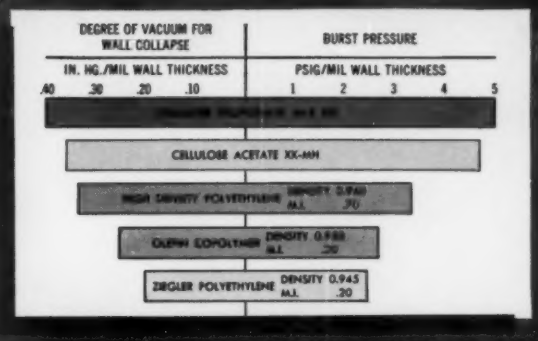
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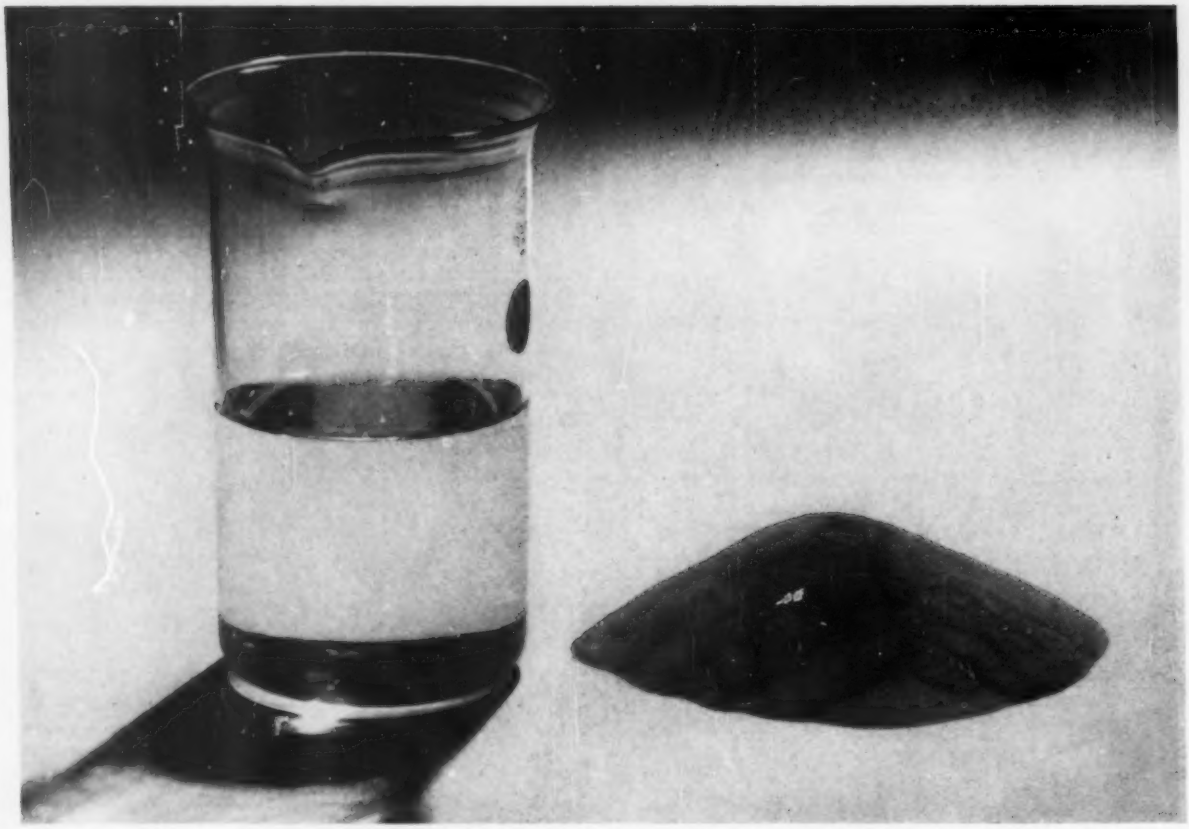

THF can dissolve moderate to high molecular weight PVC resins at low cost! As shown above, it takes only 4.6 lbs. of THF to dissolve 1 lb. of "GEON" 103 E.P.*, cost: $1.61. This is actually less than it would cost if MEK were used. In addition, you get the unique advantages of THF described at the right.

Du Pont Tetrahydrofuran Plus Rapid Diffusion

THF offers these unique advantages as a solvent for PVC homopolymers and copolymers:

1. THF yields solutions of high resin content at low viscosity. It's easier to handle . . . makes more workable solutions.
2. PVC resin can be readily dissolved in THF and put in solution without heating and with conventional stirring equipment.
3. THF has good diluent tolerance for toluene and other extenders.
4. Rapid diffusion and evaporation rate of THF permits higher machine speeds than is possible with MEK.
5. THF is easily recoverable—low-cost materials such as mild steel can be used in the recovery system . . . resulting in further substantial savings.

You get *all* of these advantages when using THF to dissolve high molecular weight resins. You can also get many of these by using THF in combination with less powerful solvents for low molecular weight resins or copolymers.

Try Du Pont THF for any of these applications:

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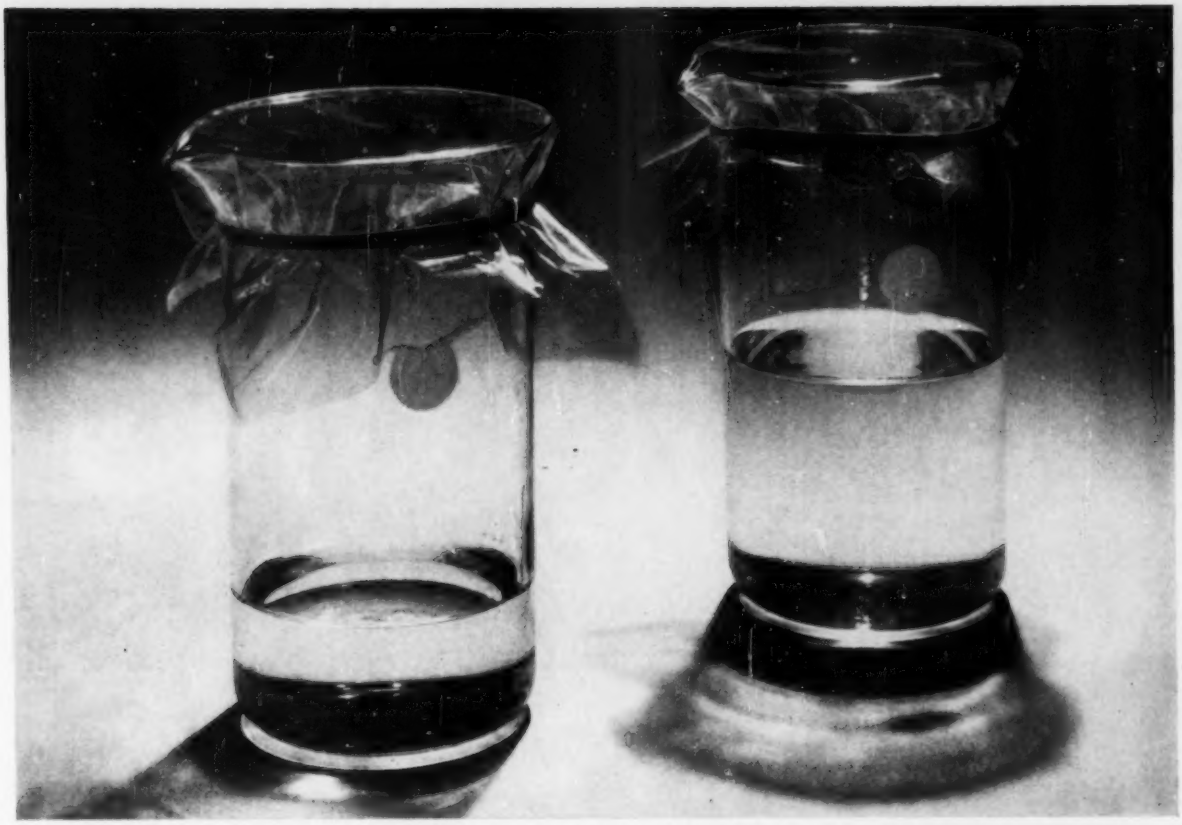

As shown above, THF diffuses through and evaporates from PVC film 2 times faster than MEK. This is why THF means faster production speeds at lower cost. Example: A ½ mil coating of "GEON" 103 E.P.* made with THF was applied at a rate of 1,600 yr./hr. for a total cost of 7.8¢/sq. yd. This is 600 yd./hr. faster and 1.5¢/sq. yd. less cost than if MEK had been used.

(THF)—High Solvent Power and Evaporation Rates!

In Top Coatings—THF yields low viscosity—high solids solutions of even the highest molecular weight homopolymers . . . increases solution stability and coating machine speeds . . . reduces solvent retention . . . promotes excellent adherence of top coat to base material.

In Film Casting—THF makes possible solvent casting of high molecular weight vinyl chloride homopolymers, resulting in stronger, more uniform films of exceptional clarity . . . increases machine speeds . . . reduces "bubble" effect and both solvent consumption and retention.

In Printing—THF permits faster press speeds . . . provides a quick bite into printing surfaces . . . reduces smearing between stages . . . its chemical stability eliminates degradation of pigment colors.

In Adhesives—THF is the best practical solvent for extruded PVC . . . rapidly softens surfaces being joined . . . its high evaporation rate in combination with less volatile solvents provides optimum tack and drying times for all types of bonding operations.

Call Du Pont for prompt deliveries of THF.

*A representative medium-high molecular weight PVC resin. Similar advantages hold for comparable resins. "GEON" is TM of B. F. Goodrich Chemical Co.

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ELECTROCHEMICALS DEPARTMENT
CHLORINE PRODUCTS DIVISION
WILMINGTON 98, DELAWARE

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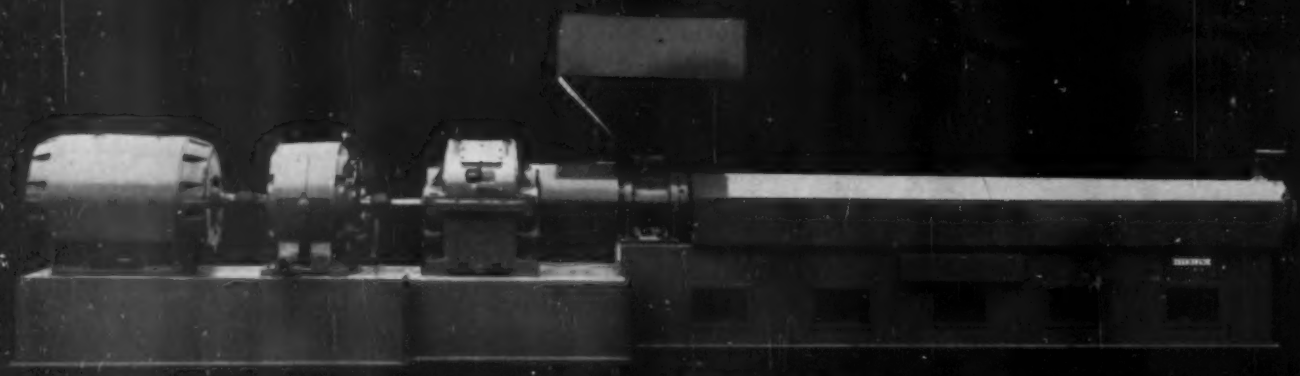
24 TONS A DAY

PRODUCED BY THIS STERLING MACHINE.....



Performance tested!
This 8" Sterling extruder with L/D ratio of 24:1 and motor drive of 400 h.p. works 'round the clock producing over 48,000 lbs. Available with screen changer eliminating the need for shutting down the machine. A superior extruder by Sterling . . . makers of a full range of competitively priced extruding equipment for blow molding, film and sheeting, compounding, laminating, wire coating and custom extrusion.

AMERICA'S FASTEST GROWING EXTRUDER MANUFACTURER

STERLING

STERLING EXTRUDERS

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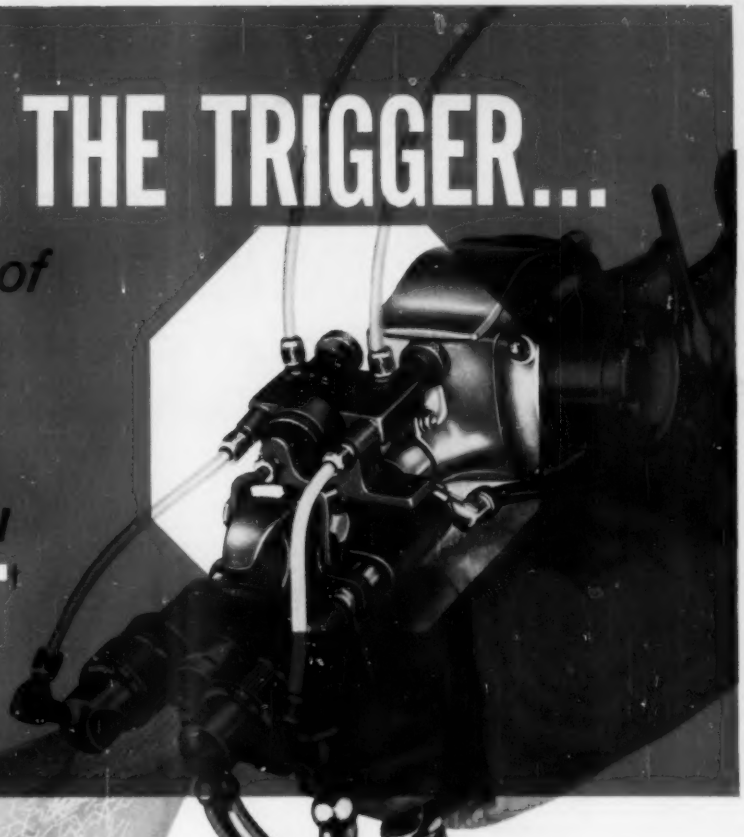
a new world of products is available!



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REINFORCED PLASTICS APPLICATOR

A combination of properties unobtainable in any other reinforced polymer applicator.

AVAILABLE IN MODELS MV, SV, BV.

■ The only reinforced plastics applicator which will apply laminate in any direction. Virtually eliminates waste. Directional control is so accurate that raw material waste may be reduced 80%. Overhead laminates may be sprayed as efficiently as vertical surfaces or floors. Sealzit applicator is not dependent on gravity to deposit the plastics laminate on desired surfaces.

■ Reliable catalyst injection integrally designed and built into plastics applicator. Just dial a number once to obtain accurate and uniform quantity control of catalyst.

■ Easiest cleanup imaginable. Upon completion of spraying, open "flush" valve to inject a few drops of solvent into the air caps and remove even trace quantities of catalyst from applicator. Sealzit applicators need not be disassembled to clean if properly flushed after use.

FLINTKOTE®

By an exclusive patented process, continuous fibres are cut and pulled into a venturi tube, then ejected through a center nozzle, fanned out into a desired pattern and instantly enveloped by liquid plastic. This plastic envelope eliminates fibre glass waste, improves wetting, makes it possible to produce low fibre glass content laminates without rolling and virtually eliminates personnel contamination.

†A trademark of The Flintkote Company.
*U.S. patent applied for. The Sealzit gun is manufactured under the following U.S. patents: 2,787,314; 2,933,125 and 2,812,751. Other U.S. patents pending. Patented in Canada. World-wide patents pending.

SEALZIT COMPANY of AMERICA
subsidiary **The Flintkote Company**
3640 Chicago Avenue, Riverside, California

Please send information on Sealzit Reinforced Plastics Applicator.

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IMS OFFERS STOCK HEATING CYLINDERS

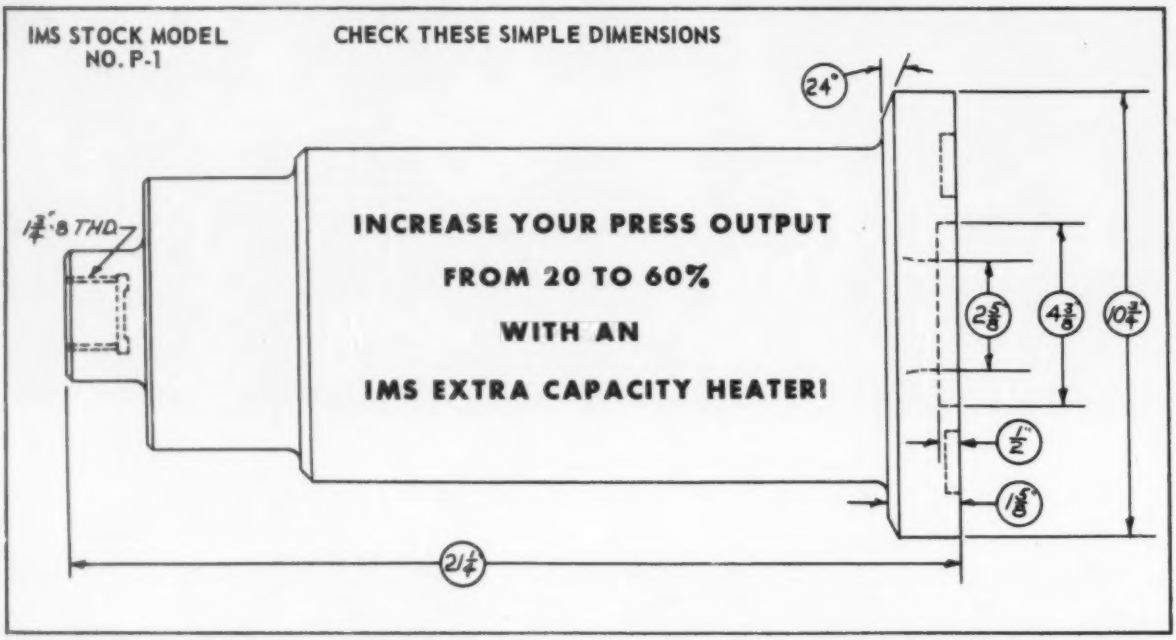
TO FIT YOUR

REED-PRENTICE 10D8 MACHINES!

IMMEDIATE SHIPMENT

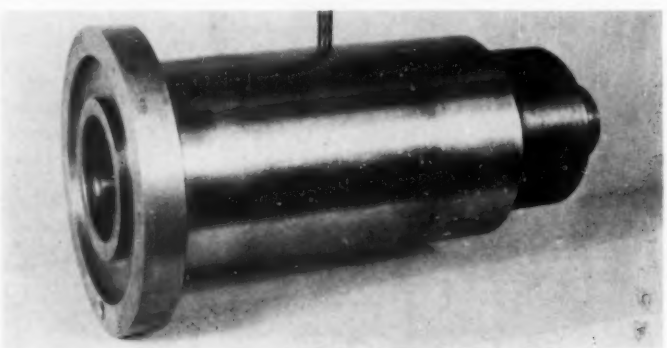
IMS STOCK MODEL NO. P-1

CHECK THESE SIMPLE DIMENSIONS



IMS Design Stock Model P-1 Replacement Heater for the popular 10D8 type Reed-Prentice machine. May be used on new style 175TA and 275TA machines with IMS Clamp Ring Adaptors.

- FOR SMALL SHOTS -
Minimize production losses! Specify IMS Stock Model P-2 Reduced Capacity Cylinder for 10D8 Reed. Same price as P-1, but only 19" long.



P-1 ... For 10D8 Reed Type 21-1/4" long $1198.50
Extra for Chrome Plate if desired...$280.00
Prices include set of Extra High Wattage Heater Bands, but no Nozzle, Cover, Wiring or Thermocouple.
1-3/4"-8 Thread Nozzles (Specify Radius and Opening) Each 35.50
Thermocouples Each $14.50

IMS INJECTION MOLDERS SUPPLY COMPANY INC.
17601 SOUTH MILES ROAD CLEVELAND 28, OHIO Phone LUdlow 1-3200

Natco "Screw-Ram" Solved Polypropylene Production Problem For General American

. . . Robert Gorman, General American Transportation Corporation says,

THE MOLDER'S MOLDING MACHINE

"The Natco Screw-Ram was the only injection molding machine which produced this polypropylene wastebasket to the critical tolerances required by our customer."

"The part presented problems due to thin walls, straight sides and no return flange on the top. We were unable to eliminate distortion until we put the part on the Natco Screw-Ram. Also, superiority in dry coloring was secured with this new Natco extruder-injection machine."

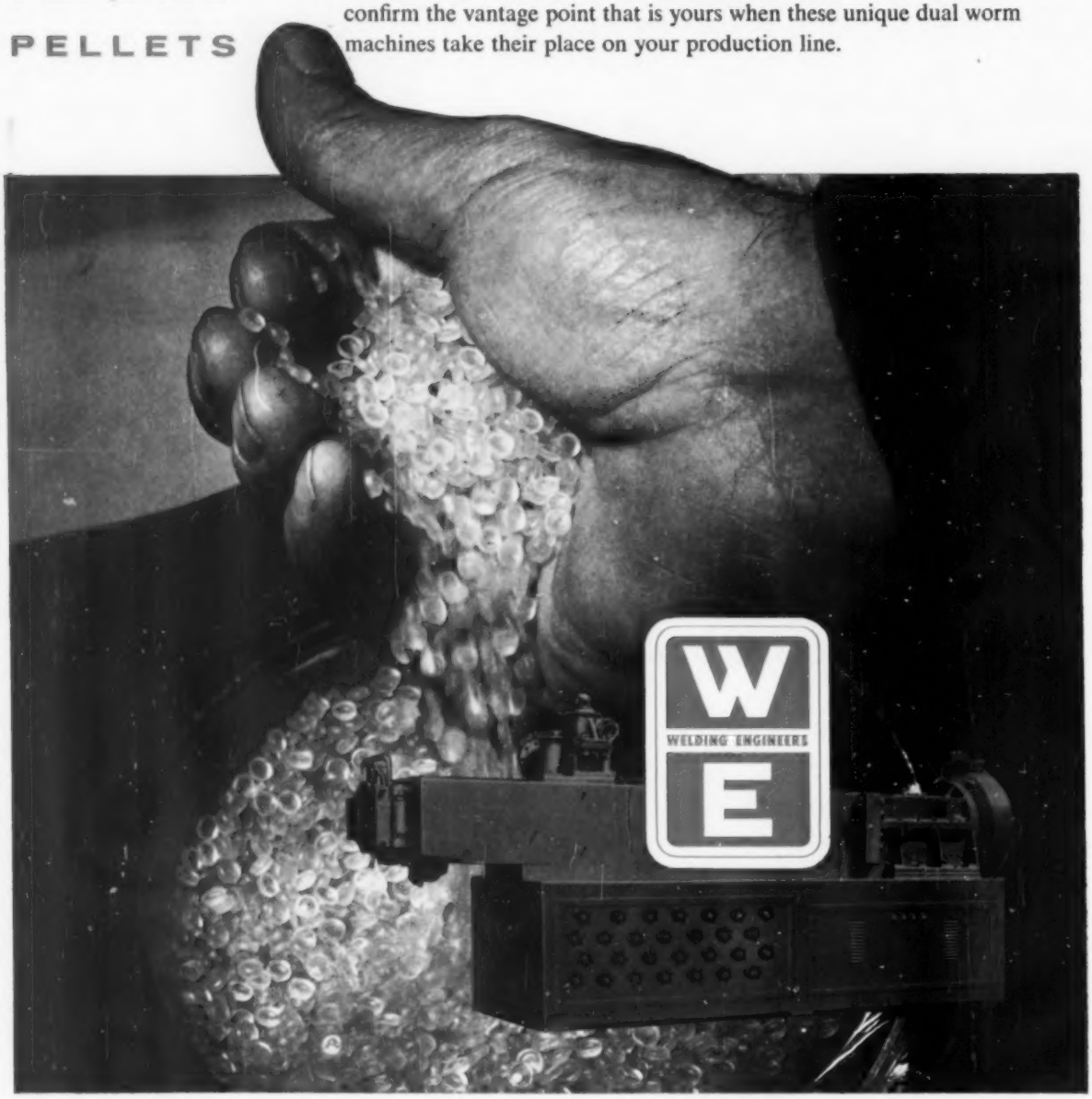
Investigate what these new Screw-Ram machines will do for you. Built in a complete range of stock sizes for 35 to 140 oz. with mold clamps of 325, 425, 650, 850 and 1200 tons. Write for complete specifications.

NATCO SCREW-RAM

NATIONAL AUTOMATIC TOOL COMPANY, INC.
PLASTICS MACHINERY DIVISION
RICHMOND, INDIANA, U. S. A.

THE HIDDEN PROFITS IN PLASTIC PELLETS

When the trained hand of the manufacturing engineer samples his production, it supplements its findings of controlled quality with the hidden benefits of Welding Engineers equipment . . . high rate complemented by trouble-free, low-cost operation. Thus quality leads the way to profits! Millions of tons of experience across the whole range of hard to handle plastics materials . . . and rubber . . . confirm the vantage point that is yours when these unique dual worm machines take their place on your production line.



Bright as are the successes of the past 20 years, they cannot compare with the goals set for the future via Welding Engineers dual worm compounder-devolatilizer-extruders. All-in-one operation, continuous, high tonnage . . . **plus quality through-and-through.** When these basic words apply to your own plans for "profits in plastics" it is time to get acquainted with the superiority of Welding Engineers equipment. Extensive laboratory facilities, using your materials if requested, are available to support your new-equipment purchasing judgement.

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the quality colorant for extrusion, injection molding, blow molding and monofilament extrusion

Maintains color fidelity and uniform dispersion on the most difficult applications. Offers exact color duplication from batch to batch. Colors natural linear and conventional polyethylenes, polypropylenes, vinyls, polystyrene, impact styrene and styrene copolymers. Simplifies inventory problems by permitting bulk ordering of natural thermoplastics at sizeable discounts. In short, rely on Gering Masterbatch to deliver the exceptional performance you need for high-quality molding . . . at considerable savings. Write for prompt answers on your specific needs.

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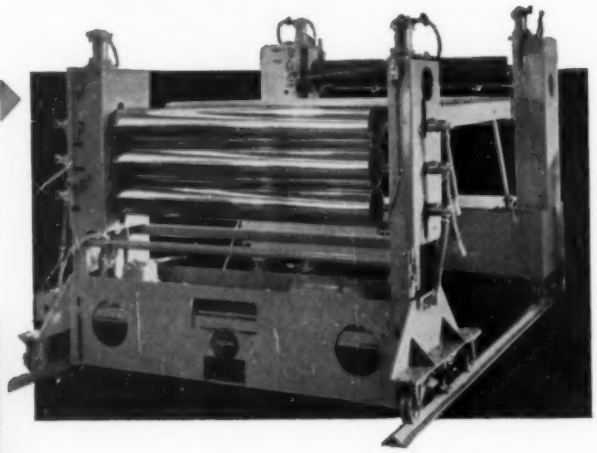
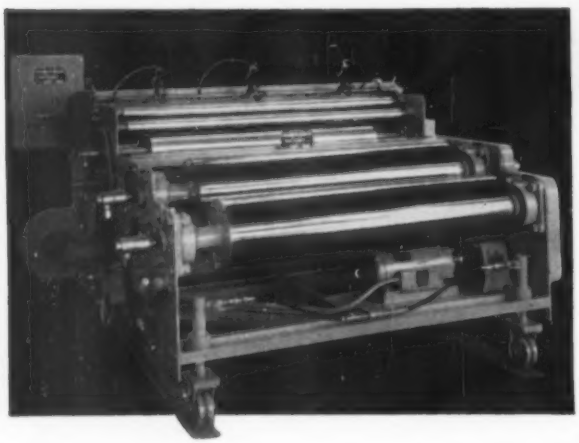
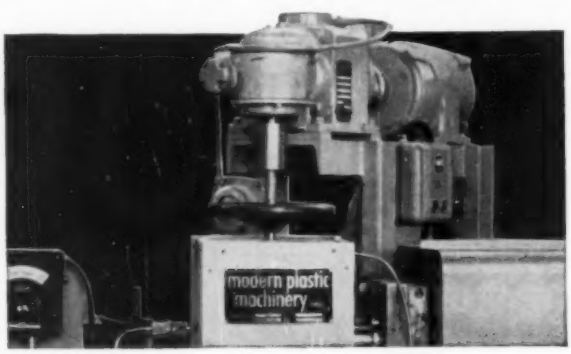
NOW EMBOSS RIGID STYRENE AND OTHER RESINS... for such products as lighting and decorative panels, new heavy sheet embossing equipment now makes casting dies for this purpose old fashioned. It's an exclusive new concept for the continuous production of any design on any standard width of rigid styrene. A complete line of MPM equipment is available for sheet embossing, from the extruder to the finished sheet.





FOR FILM AND SHEET PRODUCTION... from polypropylene, PVC and polyethylene, MPM's equipment is as up-to-date as tomorrow. MPM's patented "coat hanger" die provides uniform distribution of pressure and flow over the entire width of the film. Double shell roll construction with high velocity water flow assures a uniform temperature to produce high quality film. Roll surfaces are mirror polished to obtain the finest roll and film quality. The precise speed and tension control of our take-up units results in exceptionally uniform winding.

NEW DIE HEAD IMPROVES MONOFILAMENT PRODUCTION ... MPM's improved pump-type die insures uniform pressure, preventing breaking and uneven diameters. You're assured of constant, unvarying output and pressure regardless of pressure variations within the extruder itself. Complete monofilament lines, including extruder, dies, quench tank, godet units, drawing ovens and spoolers, are available from MPM.



For more information on these and other MPM machinery, write for our new 16-page illustrated catalog and specifications sheets.

Modern Plastic Machinery Corp.

General offices and engineering laboratories: 64 Lakeview Avenue, Clifton, N. J.

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London Electricity Board fascia sign made by Haskins, St. John Street, London, E.C.1, to the design of Watson & Coates, Architects & Planning Consultants. The fascia is edge lit, and consists of clear 'Perspex' acrylic sheet engraved on the back, and mounted against black 'Perspex'. The lettering was designed by Mr. John Farleigh and Miss Ann Camp.

Signs made from 'Perspex' stand out

This strikingly simple fascia sign, the first of its kind in this country, shows the scope 'Perspex' acrylic sheet offers for eyecatching and imaginative design. It was made by Haskins for the London Electricity Board. The lettering is engraved on the back of clear 'Perspex' sheet, which is itself mounted against black 'Perspex'. The whole fascia panel is edge lit so as to illuminate all the engraved surfaces. In addition to being suitable for engraving and inlaying, 'Perspex' can be easily shaped into virtually any letter form. It is made in a very wide range of colours, and takes printing perfectly; its smooth but very durable surface is easy to maintain and will stand indefinite exposure to the weather. To combine eyecatching design with durability, specify signs made from 'Perspex'.

'PERSPEX'

'Perspex' is the registered trade mark for the acrylic sheet manufactured by I.C.I.

ICI

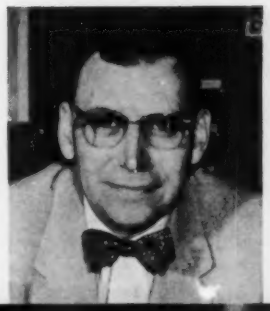
Imperial Chemical Industries Ltd., Plastics Division, Export Dept., Bessemer Rd., Welwyn Garden City, Herts., England.

U.S.A. Enquiries to: J. B. Henriques Inc., 521 Fifth Avenue, New York 17, N.Y.

Canadian Enquiries to: Canadian Industries Limited, Plastics Division, P.O. Box 10, Montreal, P.Q.

P805/O/A

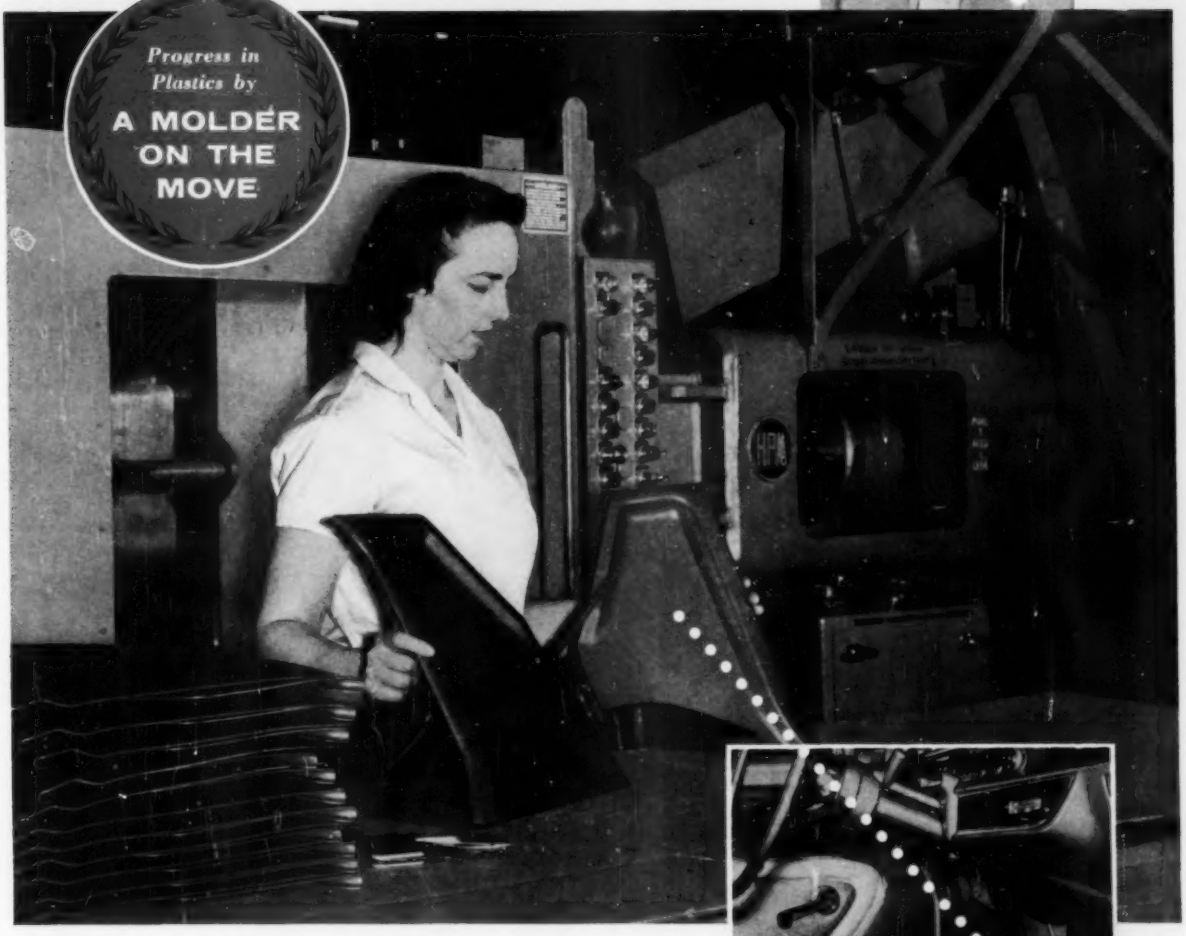
"We at Champion Molded Plastics strive to give our customers the highest quality possible with good service. To remain competitive with these high standards, we must have the best injection molding equipment available to do our job. After much study we selected H-P-M's to fulfill our purpose."

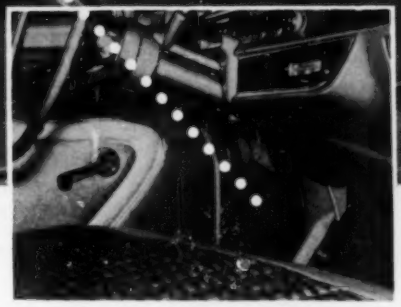


Frank Schneider

FRANK SCHNEIDER, Executive Vice-President
Champion Molded Plastics, Inc., Bryan, Ohio

Progress in Plastics by
A MOLDER ON THE MOVE





Champion molds Ford cowl panels of linear polyethylene on an H-P-M two-stage plunger preplasticizer (Model 650-P-80). The cowl panels are not only beautifully finished but are scuff-proof as well.

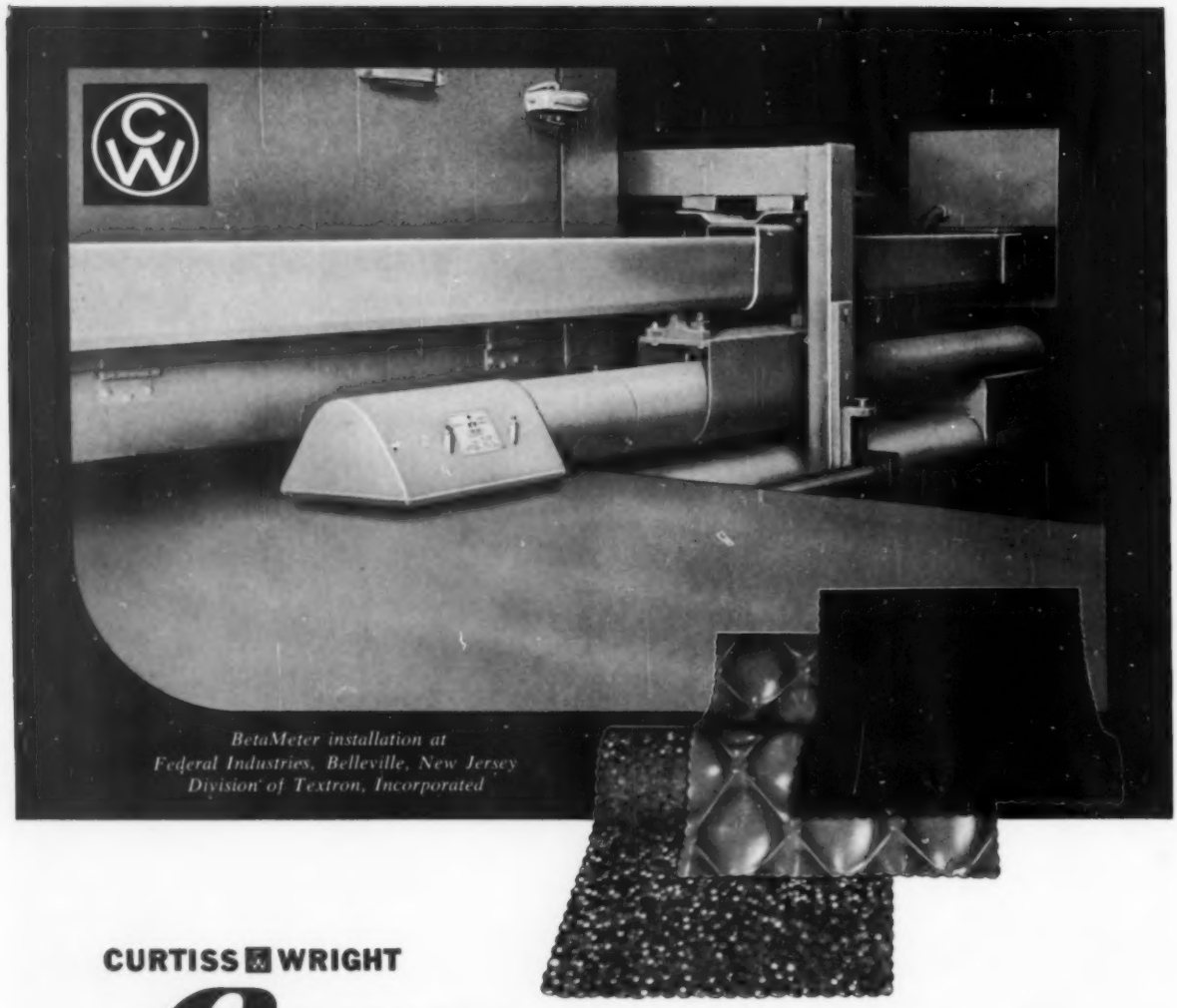
"We keep competitive with H-P-M's"

Now you can select an H-P-M injection machine "custom-built" to fit your requirements as if it were especially built for the job. This is possible because of interchangeable unit design; a wide range of clamp tonnages, types of injection, injection capacities and speeds. For information on the largest and most comprehensive line of injection machines ever offered to the plastics industry, write for H-P-M Bulletin 6101.

H-P-M DIVISION
Koehring Company
Mt. Gilead, Ohio, U.S.A.

HPM

H109



BetaMeter installation at Federal Industries, Belleville, New Jersey Division of Textron, Incorporated

CURTISS WRIGHT

BETAMETER® CONTROLS COATING . . .

ASSURES UNIFORMITY AT FEDERAL INDUSTRIES

BetaMeter at Federal permits operator to adjust and control variables for each coating specification.

Excellent quality control contributes to Federal Industries' position as a leading manufacturer of plastic coated upholstery fabrics for the automotive industry. To help maintain this rigid quality standard, Federal depends on the Curtiss-Wright BetaMeter for consistent, uniform coating applications on every run.

The BetaMeter, by means of radioactive isotopes, accurately and instantaneously measures coated stock without contacting the material or affecting the process in any way. Variations from proper thickness are instantly shown on a target meter and chart recorder. Corrective adjustments can be made during production runs easily and positively, thereby saving costly raw materials and time. The BetaMeter monitors coated stock continuously, maintains quality control and greatly reduces scrap losses.

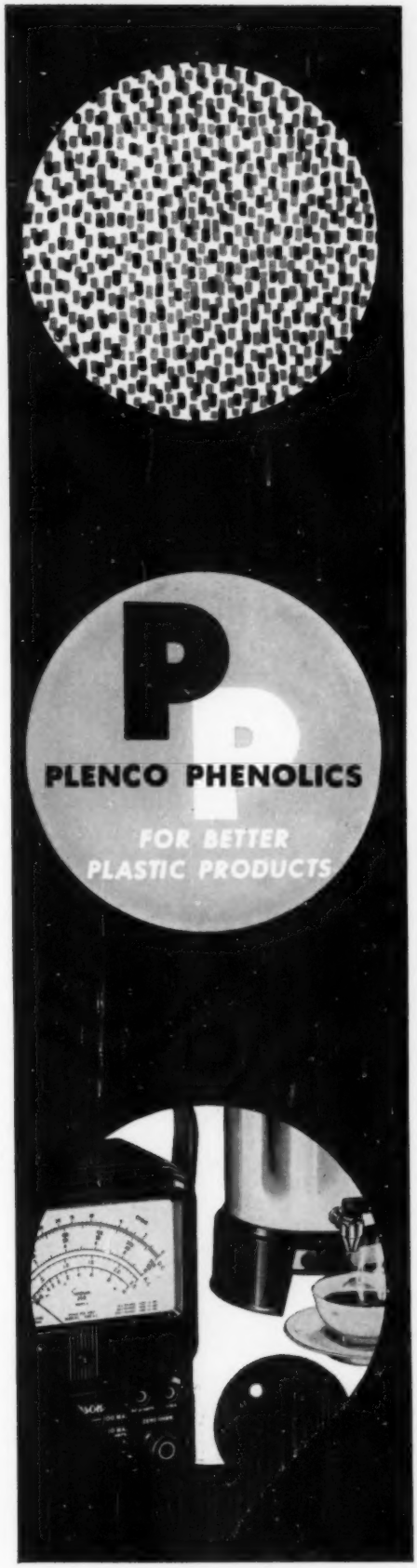
Automatic process control equipment is available for all standard BetaMeter measuring systems.

For complete details on how Curtiss-Wright BetaMeter can benefit plastic film, sheet or coated stock manufacturing operations, phone SWinburne 9-0500 or write.

Curtiss - Wright Mark II BetaMeters, for handling up to 36" webs, are priced from $4985 (Strip-chart recorder included).

Princeton Division CURTISS WRIGHT CORPORATION Princeton, New Jersey

IN CANADA: Canadian Curtiss-Wright Ltd., Industrial Process Controls, Davis Road, Oakville, Ontario.



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can answer your requirements for durability, strength, adaptability . . . can offer ease and economy of production and uniformity of quality . . . permit subminiature dimensions or relatively massive proportions . . . assure high precision, hardest wear, ability to withstand climatic, environmental, or special conditions . . . and make certain of satisfaction in product performance and appearance . . .

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from a wide range of dependable General-Purpose and Special-Purpose Molding Compounds . . . heat resistant, impact resistant, moisture, chemical, and electrical resistant compounds . . . non-bleeding compounds . . . mottles . . . colors . . . already made or custom-formulated to your needs, and available with Plenco's experienced counseling and testing services . . .

AND DOES

in countless, "hidden" industrial uses as well as attractive, "see me" consumer-product applications. There's a little Plenco (or quite a lot) in the best of things . . . and the best of companies put it there. Call us to discuss the advantages of Plenco phenolics for your product.

PLASTICS ENGINEERING COMPANY

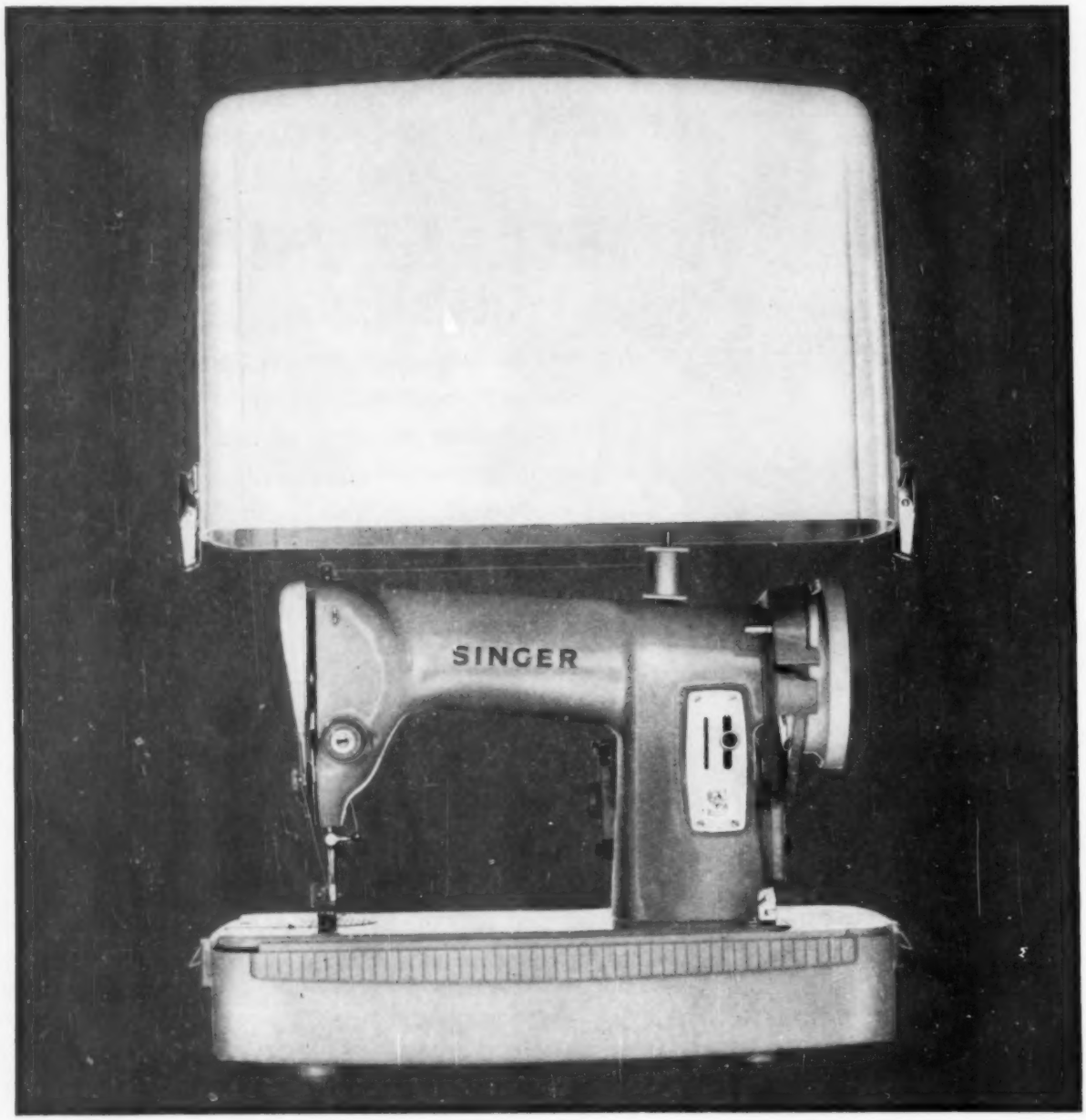
SHEBOYGAN, WISCONSIN Serving the plastics industry in the manufacture of high grade phenolic molding compounds, industrial resins and coating resins.

SINGER sews up a case with plastic!

To design their new portable sewing machine case, Singer Manufacturing Company needed a tough, lightweight material. They chose a new Koppers high-impact plastic . . . DYLENE® 400 polystyrene.

The case is exceptionally strong and weighs only five pounds! It's as compact as a small piece of luggage; easy to carry, easy to store, and it's attractive.

High-impact DYLENE polystyrene is strong, durable; it molds cleanly without sharp edges, eliminating costly secondary operations. It has a high surface gloss and smooth finish. DYLENE can take rough handling, it won't chip or break. DYLENE comes in a wide range of permanent colors.



Eight-foot giant weighs only 23 pounds

This towering store display, molded for Green Giant, is an absolute traffic-stopper. Because it's molded from lightweight DYLITE® expandable polystyrene, this 8-foot-high unit weighs only 23 pounds. DYLITE is strong, easy to mold to almost any size or contour, and easy to decorate. It's a natural for any molded part where three-dimensional detail is a must. The Green Giant was molded by Weber Plastics, Inc., Stevens Point, Wisconsin.

Plastic gives portable TV strong case against heat

Magnavox needed a high-impact, heat-resistant plastic for front and back pieces on their new 19″ portables, so they chose specially developed Koppers polystyrene —DYLENE® 800. This easy-to-mold plastic has exceptional strength, a heat distortion temperature of 195° F, and it meets all Underwriters Laboratory requirements. It molds to all colors in a glossy finish. Parts molded by Superior Plastics, Chicago, and Alma Plastics, Alma, Mich.

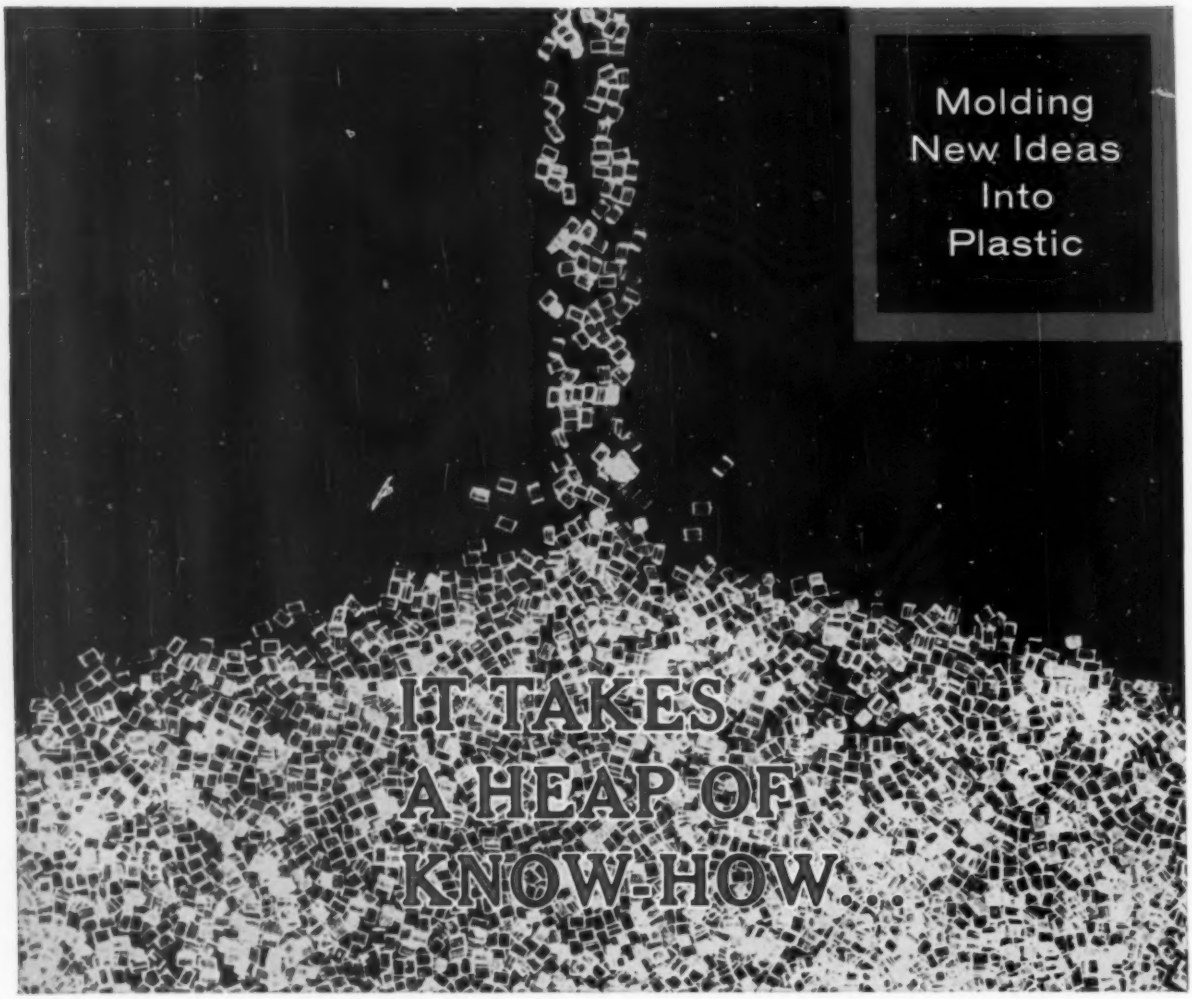
New spreader made from corrosion-proof plastic

This new lightweight Seymour spreader can dispense weed killers, insecticides, fertilizers, ice melters and seed, yet it never corrodes. The hopper is molded from tough SUPER DYLAN® high-density polyethylene. No need to worry if you drop it . . . it won't break. This spreader won't leak or absorb odors, and it's easy to keep clean. Spreader molded by Amos Molded Plastics, Edinburg, Ind. for Seymour Mfg. Co., Seymour, Indiana.

KOPPERS PLASTICS

Learn how Koppers family of fine plastics can improve your product at less cost. Contact Koppers Company, Inc., Plastics Division, Dept. 136, Pittsburgh 19, Pa.

KOPPERS®



to mold Profitable Products from Plastic Pellets

Handled right, the plastic pellets pictured above can be the best thing that ever happened to your idea for a new product, to your present product or to some of its components, but . . .

. . . it takes a heap of know-how to mold a *profitable* product from a pile of pellets. Not everybody can do it. It takes *special* talents, *special* equipment and often a special background to do a job right, and . . .

Minnesota Plastics has these "specials," knows what plastics can do . . . knows best how to apply them to your product, how to make your products better . . . to make your product *profitable*.

What's more, MPC is capable of the complete job—from basic design, through engineering, molding, assembly, painting, printing and shipping. At Minnesota Plastics, you'll save steps, you'll save time, you'll save money, and . . . these are the kinds of savings that help you get what you set out to get . . . a workable, *profitable* product made of plastic.

m p c

PIONEER MANUFACTURER OF NEW PRODUCTS IN PLASTIC

Minnesota Plastics Corporation

EAST MARYLAND AVENUE • SAINT PAUL 17, MINNESOTA

Hot sun causes some vinyls to give off volatiles that "fog" windows. Bar-O-Sil stabilizer inhibits this condition.

Tests show Bar-O-Sil* stabilizer inhibits troublesome "fogging" of car windows due to vinyls

Bar-O-Sil supplementary stabilizer also checks spewing, crocking, plating and blocking in processing of vinyl film, sheeting and extrusions.

Car manufacturers noted that heat causes some vinyl upholsteries to give off volatiles that "fog" windows. Tests show that Bar-O-Sil, complex barium silicate supplementary stabilizer, inhibits this condition in vinyls. In addition to alleviating this problem, Bar-O-Sil promotes the following desired characteristics in vinyl film, sheeting and extrusions.

Promotes colorant performance and "dry hand" qualities

Bar-O-Sil has a high adsorptive capacity that provides improved control of migration of color and plastic ingredients to the surface. Bar-O-Sil also has low reactivity with sensitive colorants. These important properties contribute to more effective control of bleeding, spewing and crocking during processing – promote desired color and "dry hand" qualities in vinyl film, sheeting and extrusions.

Speeds production runs by reducing plate-out

In all stabilizing systems containing barium, cadmium or zinc compounds, Bar-O-Sil reduces plate-out on rollers during calendering. In this way, Bar-O-Sil saves time by permitting quick color changeovers, and speeds production runs.

Other helpful benefits

Bar-O-Sil's high adsorptive capacity controls blocking of vinyls in storage and in use. The presence of Bar-O-Sil is important, especially when post-laminating or post-embossing operations are to be conducted as a separate step, some time after the initial processing stage.

Send coupon for more information

For detailed information covering the many useful properties imparted to vinyls by Bar-O-Sil supplementary stabilizer, fill out the coupon below.

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General Offices: 111 Broadway, New York 6, N.Y.
In Canada: CANADIAN TITANIUM PIGMENTS LIMITED
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BAR-O-SIL* *(Stabilizer)*

A Chemical Development of **National Lead Company**
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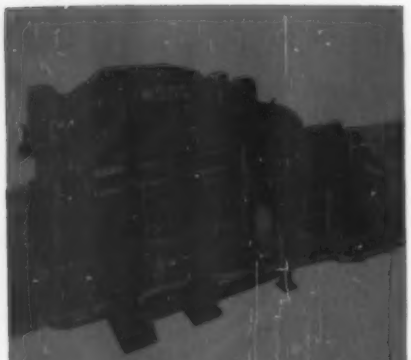

Single Opening 500-ton Embossing Press for use on leather and plastic products. Fully automatic operation with suitable loading mechanism permits pressing of sheets at rate of 12 cycles per minute. Semi-automatic controls are provided for single sheet production. For complete information on this press and other types used in the plastics industry, write us today.

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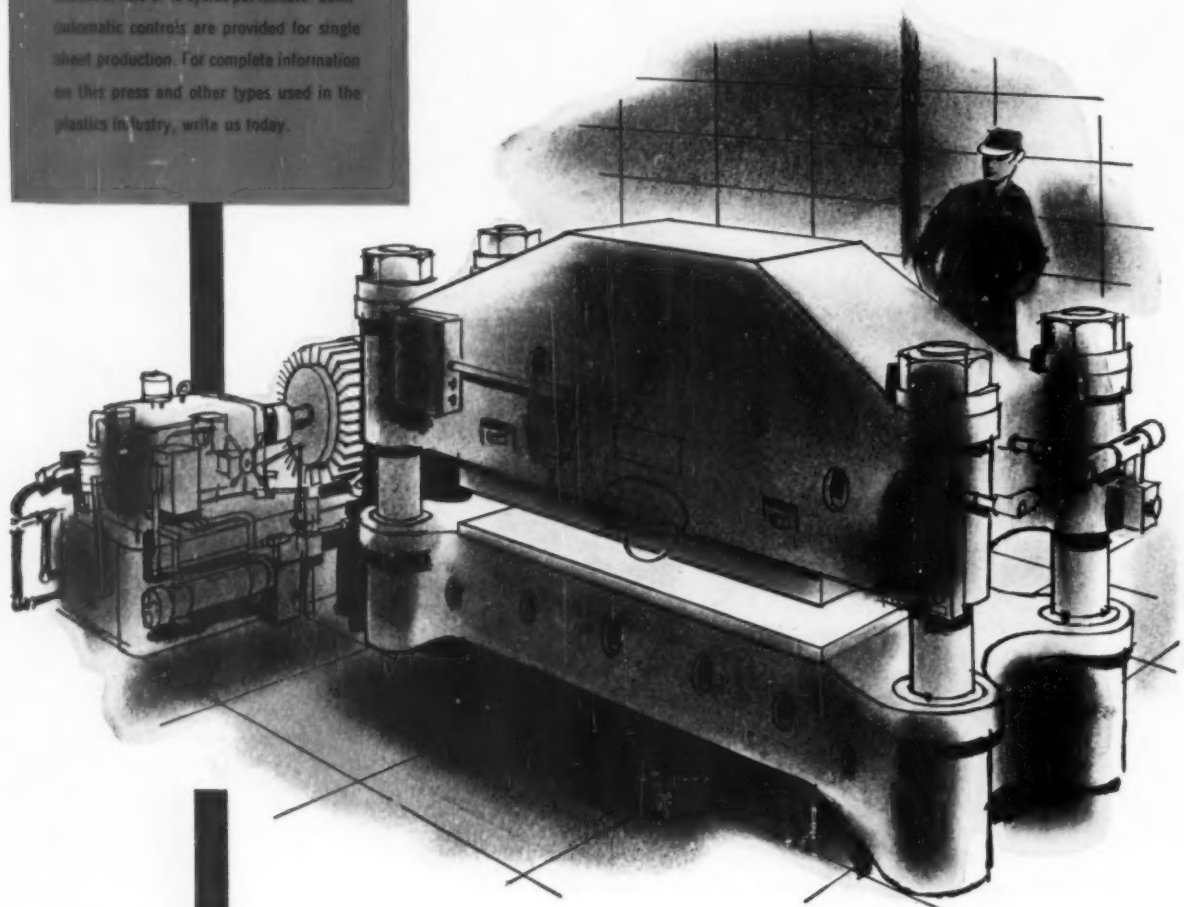

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Erie hydraulic presses for reinforced plastics molding are designed and built to meet production requirements. Custom-designed presses can be manufactured to suit your specifications over a wide range of capacities: machines with capacities from 50 tons to 1,000 tons are operating successfully in many customer plants.

In addition, standard Erie hydraulic presses, with conventional die areas, are available in a range of capacities up to 750 tons.

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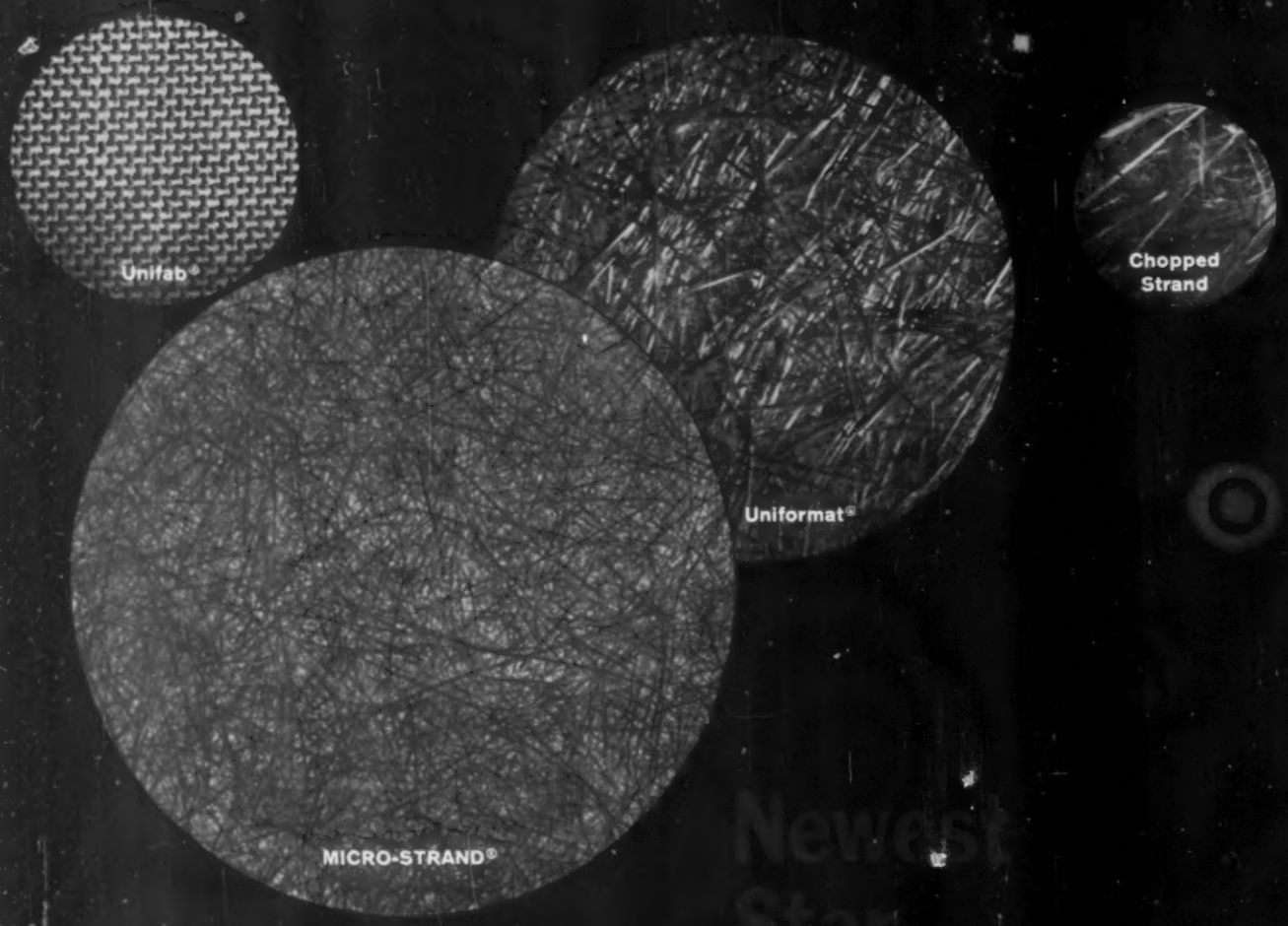

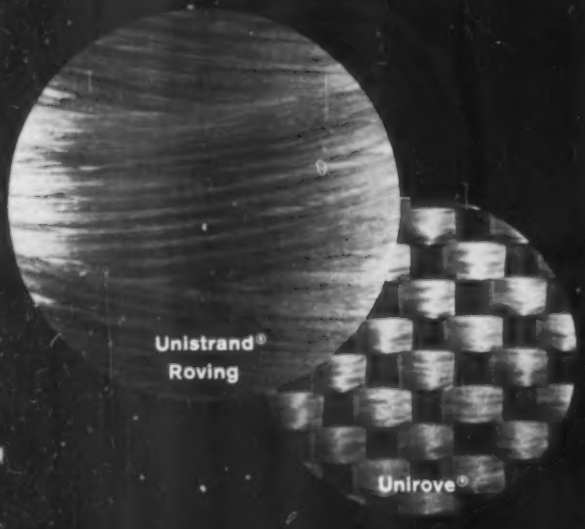

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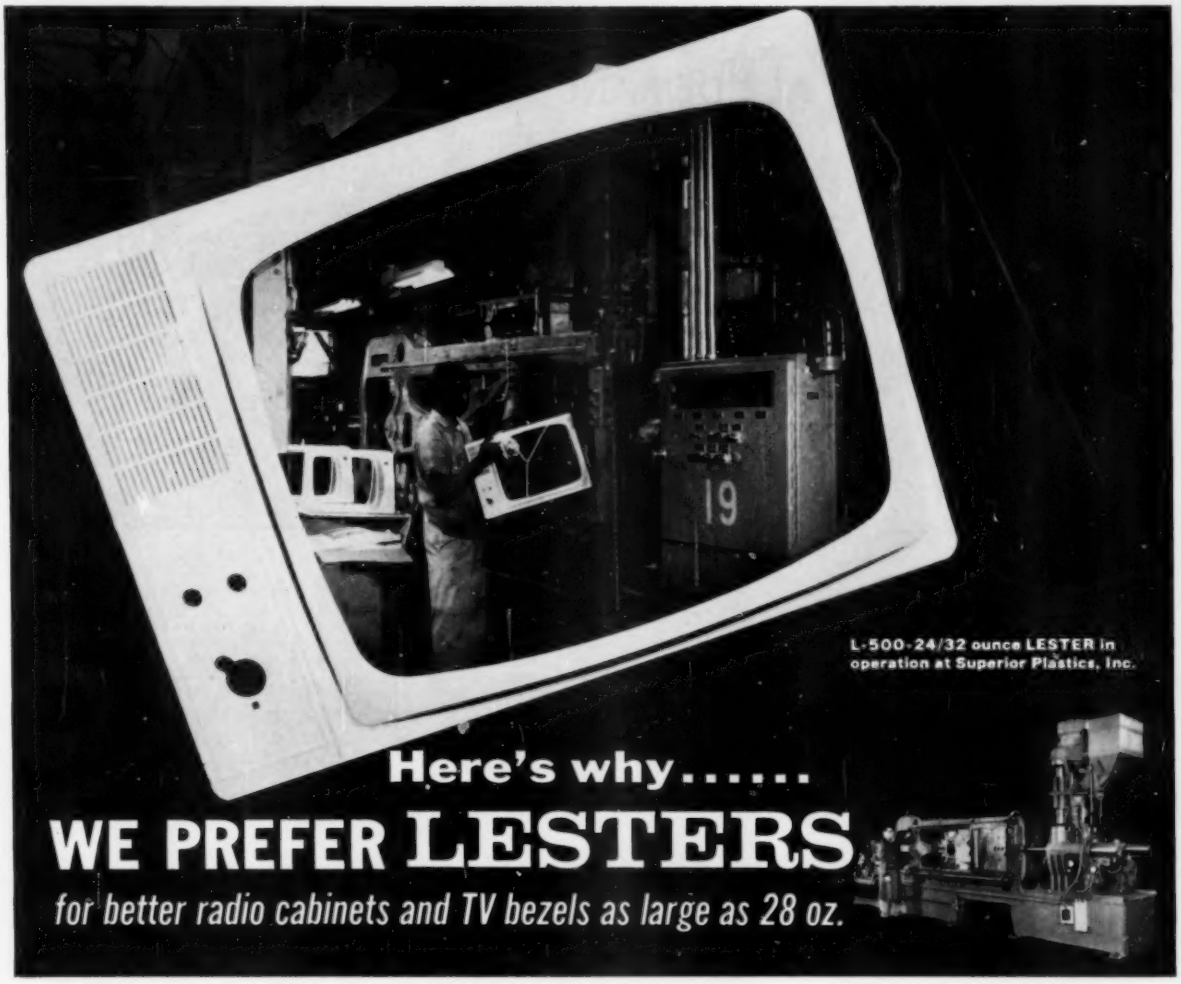

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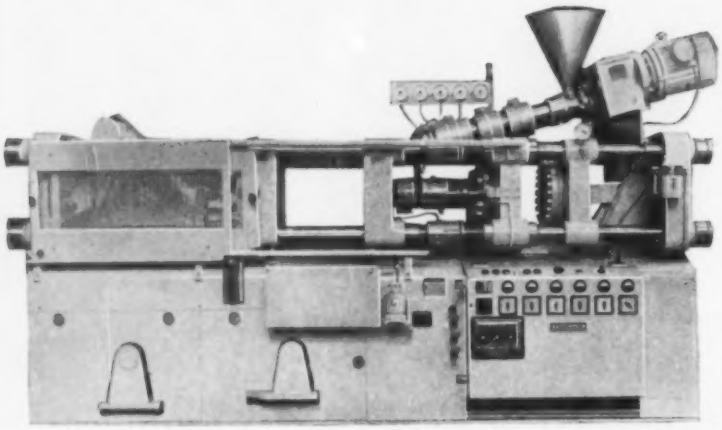

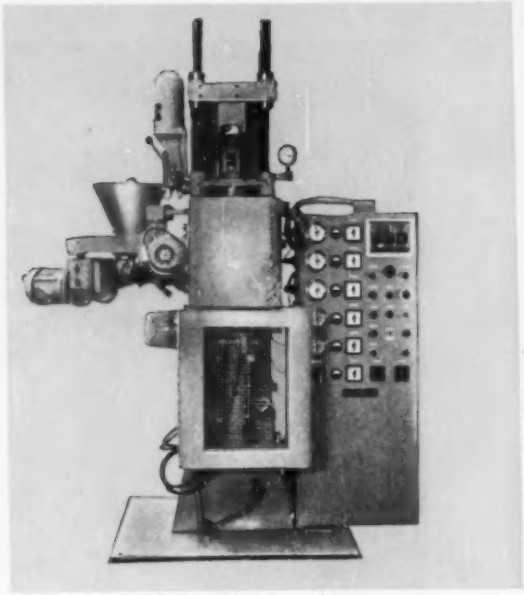

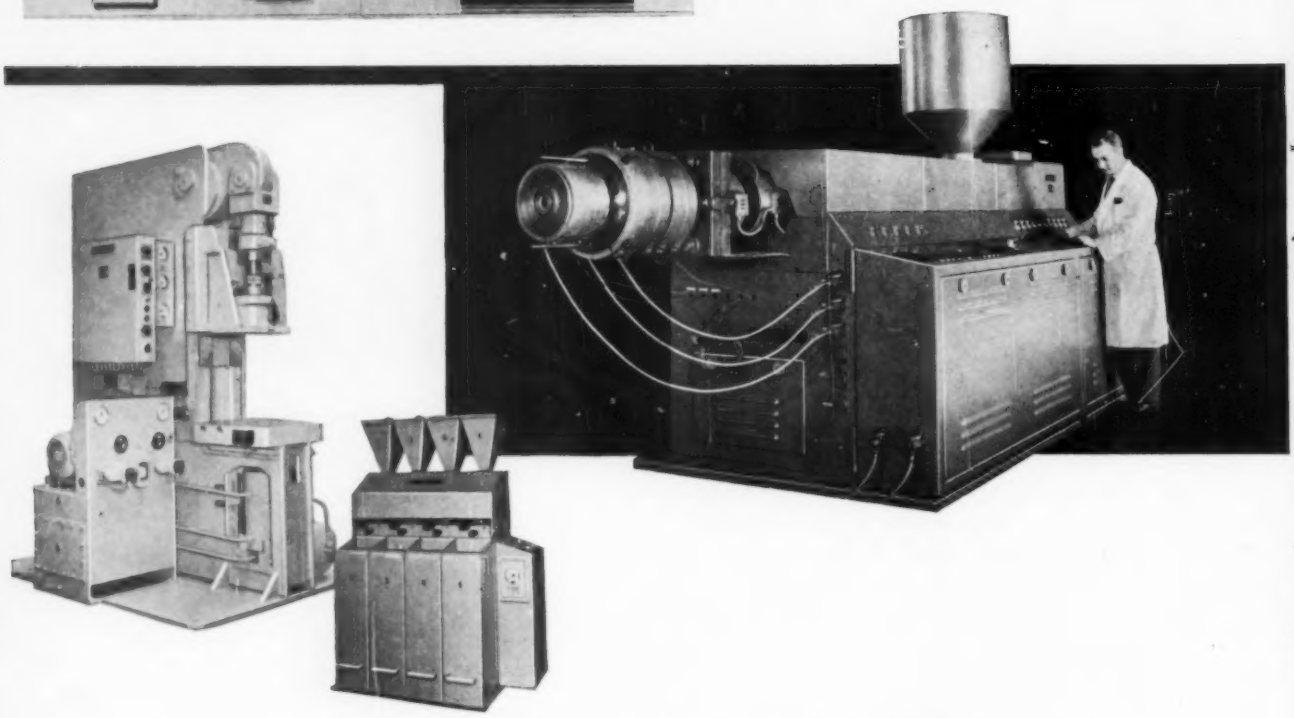

The progressive application of plastics in industry and trade requires efficient processing machines. Battenfeld automatic machines meet these requirements and impress by reliability and economical production. We are pleased to inform you of our manufacturing program and to assist you in solving all your production problems.

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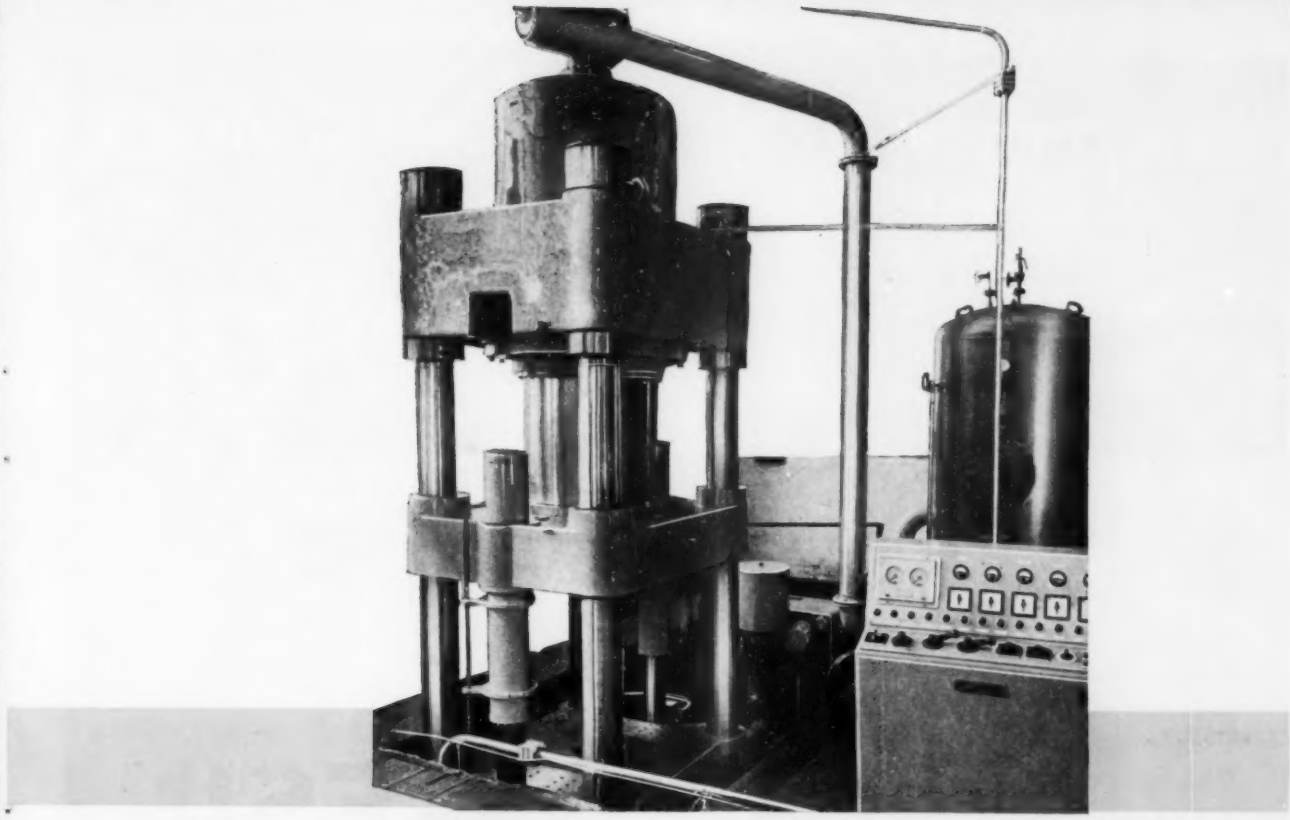

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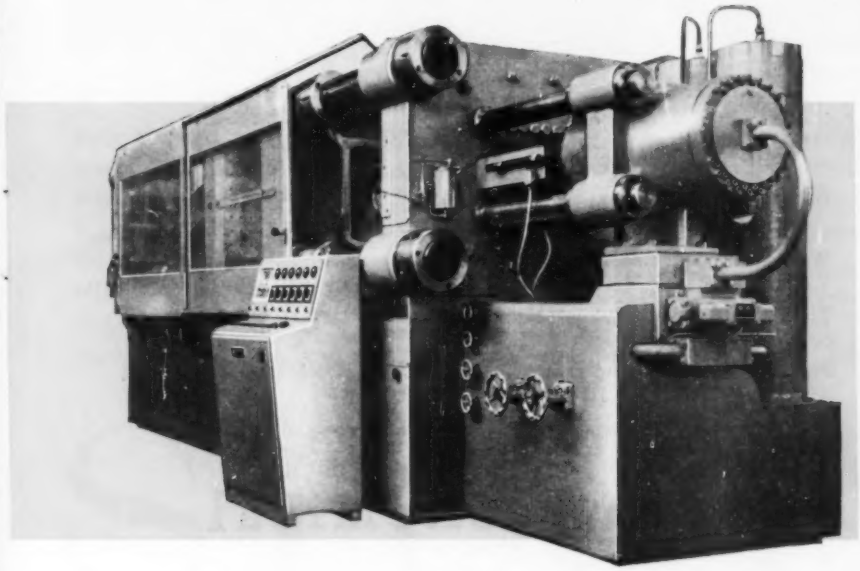

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Flex Modulus at 30% glass	1.7×10^6
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Flex Modulus of cast resin	0.56×10^6
Acid number uncured resin	15
Resistance to:	
10% boiling caustic	Excellent
10% Nitric at 140° F.	Excellent
5% Sodium Hypochlorite at 120° F.	Excellent
Steam Sterilization	Excellent
Heat Crazing	Excellent
Electrical Properties	Excellent

When you equate performance against unit cost you'll agree it's the VALUE BUY OF THE YEAR.

There is also a version containing activators so that room temperature cure can be obtained with MEK peroxide.

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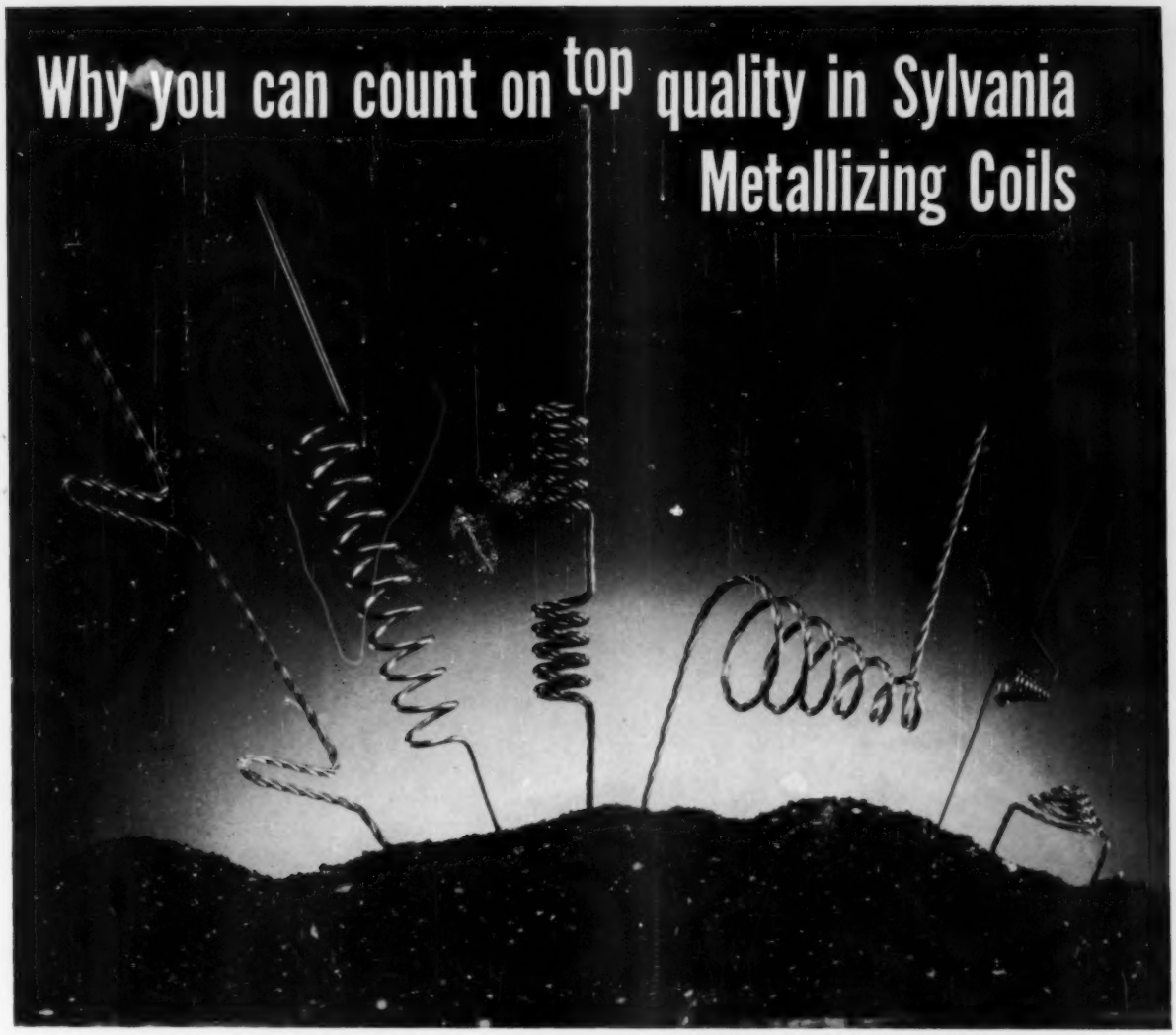
Why you can count on top quality in Sylvania Metallizing Coils



The pile in the foreground of the photo above is wolframite ore.

First, Sylvania knows the materials. Our experience in manufacturing billions of metallizing coils is your assurance of top performance.

Second, in making these coils, Sylvania *starts* right with the ore and maintains maximum quality control from refining straight through the finishing process.

Third, our plant flexibility is such that you can name the design and Sylvania can produce the coil. In standard designs you can even name the quantity and, chances are, Sylvania can supply your needs *right off the shelf*.

Result: you get highest quality coils at volume prices—and you can be sure of efficient, uniform metallizing.

For further information—and outstanding technical help with your vacuum-metallized problems—write Chemical & Metallurgical Division, Sylvania Electric Products Inc., Towanda, Pennsylvania.

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GENERAL SYSTEM

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New simplified spray gun applies dual component materials as easily as paint

And it's as easy to handle as a conventional spray gun. ▪ Because it has sensitive, accurate adjustments for producing normal fan or round type spray patterns, no special spraying technique to attain more uniform film builds is required. ▪ Gun is designed to spray lower viscosity polyester materials, attaining improved intermix, better flow-out and higher film build. ▪ Component materials mix thoroughly in the spray pattern as they leave the gun and before they reach the surface. ▪ This intermixing outside the gun eliminates problems of material setup in the nozzle and the need for immediate gun flushing characteristic of short pot life mixtures. ▪ For full details on the new DeVilbiss dual component spray gun, write us direct. The DeVilbiss Company, Toledo 1, Ohio.

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INJECTION MOLDED—This hospital footstool is typical of the products and parts made of MARLEX for hardware, auto, appliance, furniture, housewares, toy, and other industries. (Footstool, Consolidated Molded Products, Scranton, Pa.)

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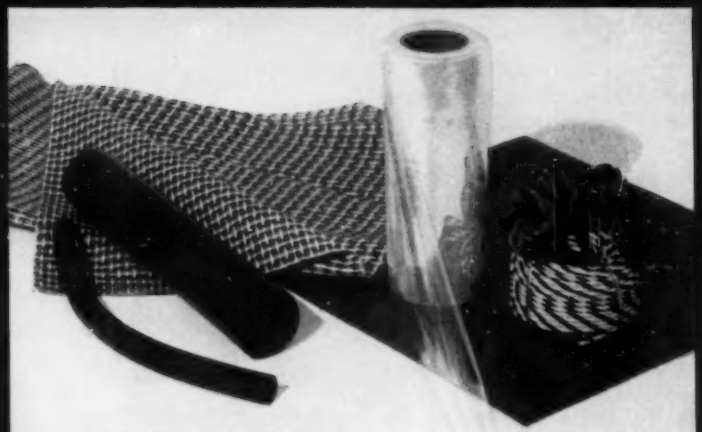
MARLEX high density polyethylenes, ethylene copolymers and tailored resins afford you versatility and outstanding product quality at moderate cost. They enable you to produce items which are durable, tough, light, corrosion proof and rot proof . . . and produce them at low cost. Products made of MARLEX withstand temperature extremes (-180°F to 250°F)... acids, alkalies, oils and greases. Get complete information about MARLEX today! Your inquiry will get prompt attention and an early response.

*MARLEX is a trademark for Phillips family of olefin polymers.



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fitted with Single-Screw Pre-plasticiser

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* The Windsor range includes INJECTION MOULDING MACHINES in capacities from 1 to 210 ozs. and EXTRUSION MACHINES with outputs up to 450 lbs. per hour.

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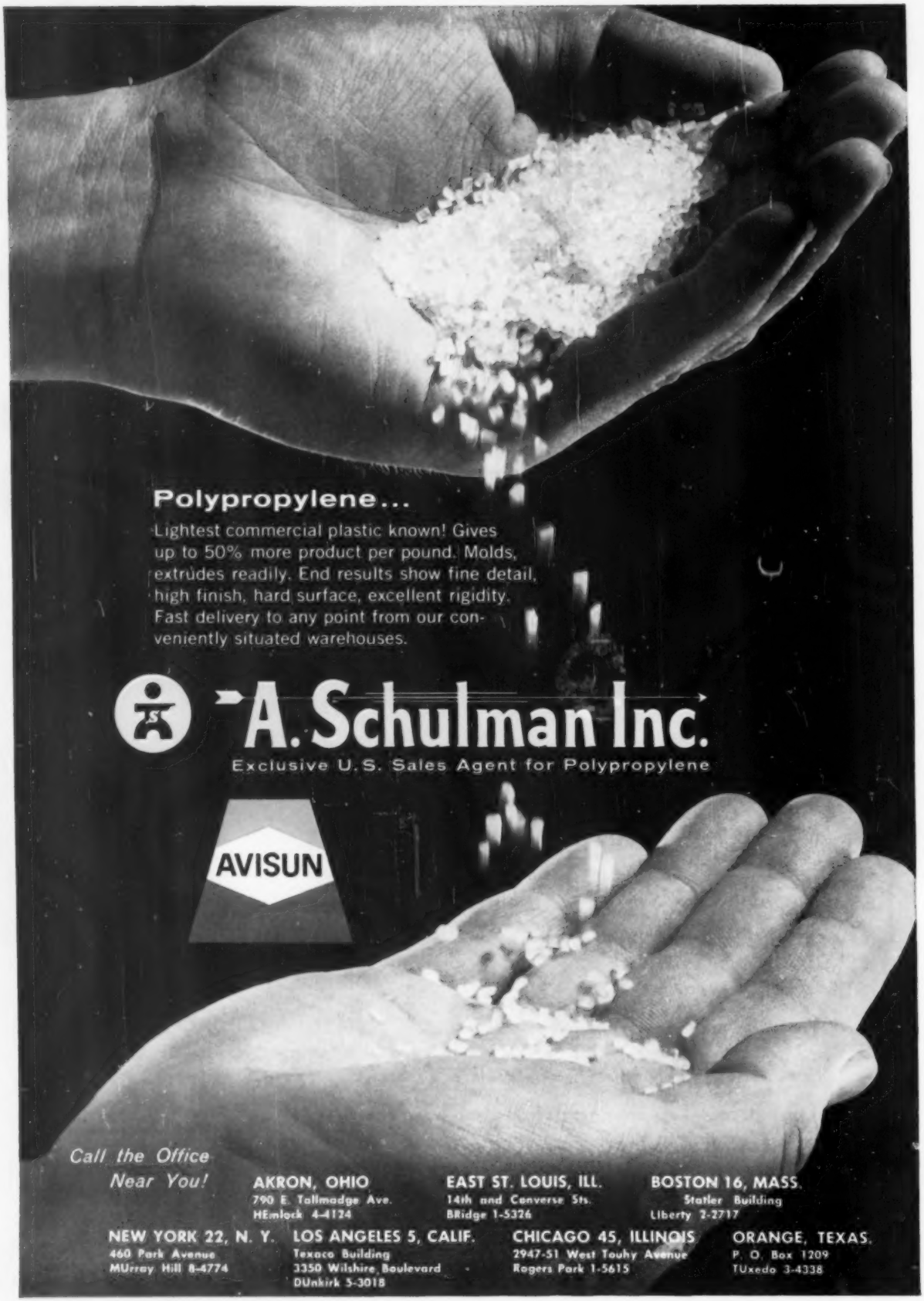
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THE PLASTISCOPE*

News and interpretations of the news — By R. L. Van Boskirk

Section 1 — September 1961

High-density PE suit settled

The Du Pont Co. and Phillips Petroleum Co. announced on Aug. 23 that they have agreed upon a settlement of litigation between the two companies over a composition of matter patent on high-density polyethylene. The settlement involves an exchange of patent rights. Du Pont is moving to dismiss the suit which it filed in June, 1958.

Plastics on way to record volume year?

The nation's industrial output in July rose to 112% of the 1957 average. It was a record—previous high was 111% in January 1960. Last February was only 102%, so the July figure represents a pretty fast comeback. The National Purchasing Agents said the hoped-for "fair second quarter" is a reality and it would appear that the hoped-for better third quarter is developing. And it would appear that the plastics industry is ahead of the pack—on its way to a record year unless there is a sudden collapse. According to sales managers, May could be the largest volume month on record up to that time, June held close to May, July was surprisingly good with the seasonal downturn less than usual, and August seemed to be back up to June volume or more. There is still some questioning about the permanence of the resurgence, over-capacity, and low profits but the shouting about these things has calmed down to a disgruntled mumble or maybe it's just a distant, even though possibly an ominous, rumble.

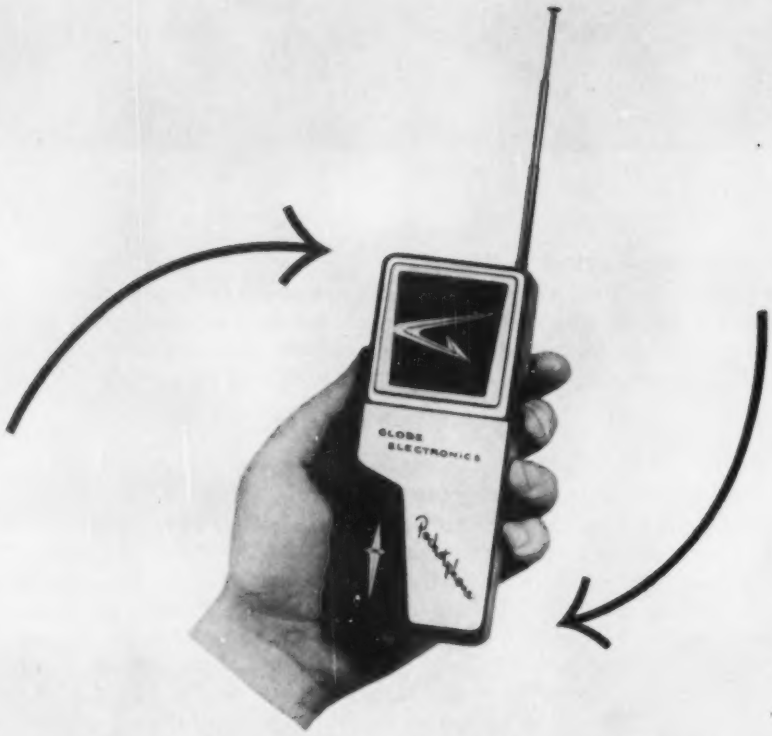
Polyethylene sales were over 700 million lb. in the first six months, as against not quite 600 million in 1960. PVC was almost 450 million lb., slightly over last year; but it went through a terrible month in February. Polystyrene was on a romp with over 50 million lb. in each of the last 4 months of the period compared to 44- to 48-million-lb. months in 1960 (this does not include exports, but the higher figure may be partially due to some companies that didn't report in 1960). Phenolic molding powder in 1961 is slightly under 1960, but this was due to a most exceptional month of 22 million lb. in March of 1960. May and June of 1961, with around 17 million lb., were good. Other phenolics were well ahead of 1960 in most cases but more companies are reporting to the Tariff Commission than in previous years. Other plastics were practically all running ahead of 1960. If the upsurge continues into the usual increased business this fall, plastics will certainly go well over any previous year.

Polyethylene is still the leader

Polyethylene sales are booming along at an unprecedented rate, with May exceeding 137 million lb.—a record—and June close behind at 127 million. The industry has been over 100 million lb. per month ever since August 1960, and the increases are in practically every end use, including exports, but film is far ahead. From an estimated 350 to 370 million lb. of resin used in 1960, film resins should be well over 400 million lb. in 1961.

The history of low-pressure (high-density) PE in **(To page 43)**

*Reg. U.S. Pat. Off.



A jolt-taking, better looking case at a savings in cost

Globe electronics was faced with a challenge . . . perhaps you have a similar one right now. They wanted their new, tiny 'Pocketphone' 2-way radio to have a modern case with eye appealing design and a rich lustrous finish. It had to be a thin walled material of high impact strength. Added to these was the important factor of cost.

Once again, CMPC—in consultation with Globe design engineers—was called upon to exercise its more than 40 years of experience in solving unique engineering problems. ABS was chosen as the material which best met all needs—including cost. Now, this smallest 2-way radio's outside case, battery case, and send-receive knob are custom molded by CMPC.

Why don't you bring your manufacturing challenges to a Chicago Molded engineer. He'll have the right answer for you.

Send for new brochure "Design and Purchase of Custom Molded Plastics"

CMPC

CHICAGO MOLDED PRODUCTS CORPORATION
1020 A North Kolmar Avenue
Chicago 51, Illinois

1961 is interesting. In 1960 monthly sales ran from 10 to 16 million lb., with good increases due to bottles in the last six months. In the first six months of 1961, sales ran from 14 to 23 million lb., with a decline to 19 million in June. The drop is said to be due to confusion over a price decline. It is also asserted that some types, such as the new particle-formed resins for bottles, are scarce but it is also noticeable that bleach bottles are now well on the way and will eventually surpass even detergent bottles. Total sales of high-density blow-molding resins in 1961 is expected to reach 85 to 100 million lb., of which 85 to 90% will be for bottles. Injection molding of high-density is expected to be from 75 to 85 million lb. in 1961.

Impact polystyrene on the move

The significant thing in polystyrene growth for 1961 is the resurgence of impact and copolymer grades, which were over 186 million lb. in 1961 compared with about 155 million in 1960. Total for the year of all domestically sold general-purpose polystyrene could be around 650 million lb. with an additional 100 million for export, according to government reports. But several producers of general purpose PS report on an annual basis only and are not included, so total of all PS for 1961 could go over 900 million lb. if present growth continues. Main factor is increased packaging market, but refrigeration uses should be slightly over 1960 and housings of various descriptions should be well over 1960.

Low cost spreads across the vinyl chloride industry

Last month the price situation concerning general-purpose vinyl (primarily calendering and extrusion resin) was discussed in this column. While general-purpose material represents by far the largest portion of all vinyls sold, there are big outlets for specialty resins, too; and they also have been affected in various ways.

Floor covering resins are an example. The material used for vinyl-asbestos flooring is generally a copolymer. It once commanded a higher price than general-purpose material. But at a 17 to 20¢ price it creates even less incentive on a producer's part than 17.5¢ general-purpose, since the other polymer, vinyl acetate, is priced higher and the copolymer involves slower production rates.

The resin used in homogeneous vinyl flooring is generally PVC and is now 17.5¢, at least theoretically. When PVC was 27¢, the resin price for vinyl in homogeneous flooring was considerably lower; but special grades were used at a lower price to help capture the market, which effort has been successful. It seems incredible that it could go below the price for general-purpose resin, which now varies from 16 to 17½ cents.

Plastisol resin for another type of flooring is 24¢—a big drop from its 34¢ price in 1955. At present, plastisols of all types represent a 100-million-lb. market; but there are only seven of the older companies who have been able to market a satisfactory resin for this purpose.

Resins for recordings are also primarily a vinyl chloride-acetate copolymer, but price has come down from 32¢ a few years ago to 20.5¢, and competition is getting fierce. Many producers have entered this field, and the market continues to grow; but it is no longer a market that bankers would consider a satisfactory profit-making business.

Rigid copolymer resins for calendering are 35¢ but **(To page 45)**

RESEARCH REPORT

MOL-REZ SYNTHETIC RESINS

PLEOGEN

SERIES 2000

POLYESTER GEL COATS

Light-stabilized isophthalic vehicle combined with time-tested pigments in an improved formulation that gives the ultimate in spray-ability, weatherability, and general physical properties.

Now PLEOGEN gel coats by Mol-Rez are formulated ready-to-spray; viscosity adjustments are unnecessary regardless of the type of spray equipment or the color of the gel coat. These gel coats are distinguished by excellent levelling, even cure, absence of porosity, superb hiding power. All colors sold have passed rigorous outdoor-exposure tests to insure light-fastness and gloss-retention. Available in white (PLEOGEN 2048-3), translucent (PLEOGEN 2055-3), and 23 standard colors. Special colors made to order for large-quantity applications.

Write today for Bulletin M-25 and 1962 gel coat color cards.

MOL-REZ DIVISION
American Petrochemical Corporation
3134 California St. N. E.
Minneapolis 18, Minnesota, U. S. A.

the market is small. Rigid compounds for pipe and sheet materials are now in the 36 to 38¢ class—were recently reduced to meet competition from other plastics.

How much will lower price increase volume?

Although considerable comment has been received concerning the low price of vinyl chloride and its profit-sapping results, several of the more optimistic producers offer the opinion that the low cost may yet be a bonanza resulting in increased markets that have heretofore been relatively small or even non-existent. The growth of resins for floor covering, from only 10 to 15 million lb. in the early 1950's to its present approximately 150 million lb., after lower prices were applied is a case in point.

Some of the applications mentioned that can be affected are as follows: magazine covers and rigid vinyl book covers; a greatly expanded wall covering market; rigid vinyl house siding that will eventually overcome its present faults; rigid vinyl packaging, which is a mere iota of what it could become, and blow-molded bottles for some markets where PE is unsuitable; reinforced vinyl tarpaulins and even unreinforced heavy sheet vinyl tarpaulins, with fire proofness a desirable factor; molded rigid vinyl fabricated by high-frequency sealing into electric shaver housings, window frames, etc.; drapery and window curtain uses can probably be increased; embossed records (voice and music) that can be used in publications; vinyl liners for ponds, reservoirs and water storage can be important in areas where soil structure is porous; and even such an already large market as welting can be greatly increased in all sorts of applications. Vinyl-to-metal laminates are still in their infancy. And so on, *ad infinitum*.

Growing market for vinyl-wood flooring. Just as the above copy was being prepared a fast notice came in calling attention to a new 9 by 9-in. tile consisting of an aluminum foil core between two layers of genuine hardwood veneer with a 12-gage clear vinyl film on the top surface and an 8-gage vinyl film on the bottom. The construction, with an over-all thickness of $^{3}/_{32}$ in., is backed with a Neoprene-saturated asbestos sheet. Retail price is from 50 to 55¢/sq. foot. A wear guarantee for the occupancy of the house is given. This is another example of what can be done in floor covering uses for vinyl and is indicative of the ever-spreading use of vinyl laminates with other materials.

More expansion in vinyl chloride

The first phase of the expansion plan of Cary Chemicals Inc. will be construction of a new 100-million-lb. polymer plant near Burlington, N. J., which will begin operations in late 1962. A 50-million-lb. plant will be built in the Midwest later. These two plants will bring Cary's total polymer capacity to 200 million pounds. Monomer will come from Tenneco Chemical, a subsidiary of Tennessee Gas Transmission Co. and an associate of Cary, by tanker from Houston. At the same time, Great Bay Chemicals & Plastics Inc., a Cary subsidiary, is expanding its calendering facilities by 166 percent. George F. Blasius, president, said company sales are at a $12-million level but would have been $14 to $15 million except for the drop in resin prices. He expects $50 million by 1965. When the new plants are on stream, the industry will have over 1.5 billion lb. of capacity and is now selling at around a rate of 900 million lb. per year. **(To page 47)**

molded of MERLON®

POLYCARBONATE

with a diploma from the school of hard knocks

Designing protective headgear is a good way to learn about materials. Take a fireman's helmet, for example, that has to withstand everything a four-alarm disaster can throw at it. What would you make it of?

Starting over a year ago, Mine Safety Appliances Company, specialists in the design and manufacture of protective devices for industry, began the hard-headed investigation that led to the selection of Merlon polycarbonate as the material for their new line of fire and industrial safety headgear.

Reasons? Count 'em: 1) impact and puncture resistance greatly exceeding 40 foot pounds, 2) good dielectric properties, 3) high and low temperature resistance, 4) self-extinguishing qualities, 5) high flexural strength and rigidity, 6) high strength-to-weight ratio. For your needs, add high dimensional stability, transparency, low creep and easy colorability.

These are some of the reasons Merlon is the new quality standard of the high-impact engineering thermoplastics. For complete test data, comparative performance properties or technical assistance, write Mobay Chemical Company, Code 6116, Pittsburgh 5, Pa.

A product of

MOBAY

M-5

SPACE A-24 Plastics Show of Canada, Toronto, October 17-19

THE PLASTISCOPE

Pantasote also increased its volume of polymer production in its Eleonora Div. plant to provide 50 million lb. a year. The company will include copolymer resins for the phonograph record field in its expansion plans after two years of experimentation. Vinyl resin sales for records in 1960 are estimated at between 50 and 55 million lb., and 1961 may not show more than 56 or 57 million. About 35 million lb. of resin went for the 100 million 12-in. records made last year—or 3 records to a pound of resin. Of the other 150 million records produced, about 15 million were 7-in. that go 7 to a pound, but a considerable amount of scrap from the 12-inchers goes into them. The larger records are about 98.2% pure vinyl copolymer. The balance of the records were 16-in. for radio transcription, export, and miscellaneous. The battle for resin sales for phonograph records is getting tougher and tougher as more companies start making the resin.

Integration in polypropylene fibers

Enjay Chemical Co. and J. P. Stevens & Co. Inc. have purchased the operating assets and facilities of The National Plastic Products Co., and have formed a jointly-owned company which will continue the National name and management. Enjay produces polypropylene; Stevens is a textile firm; National manufactures fibers. According to the companies involved, the move is designed to accelerate commercial development of polypropylene and other new fibers.

Another polypropylene replacement for metal

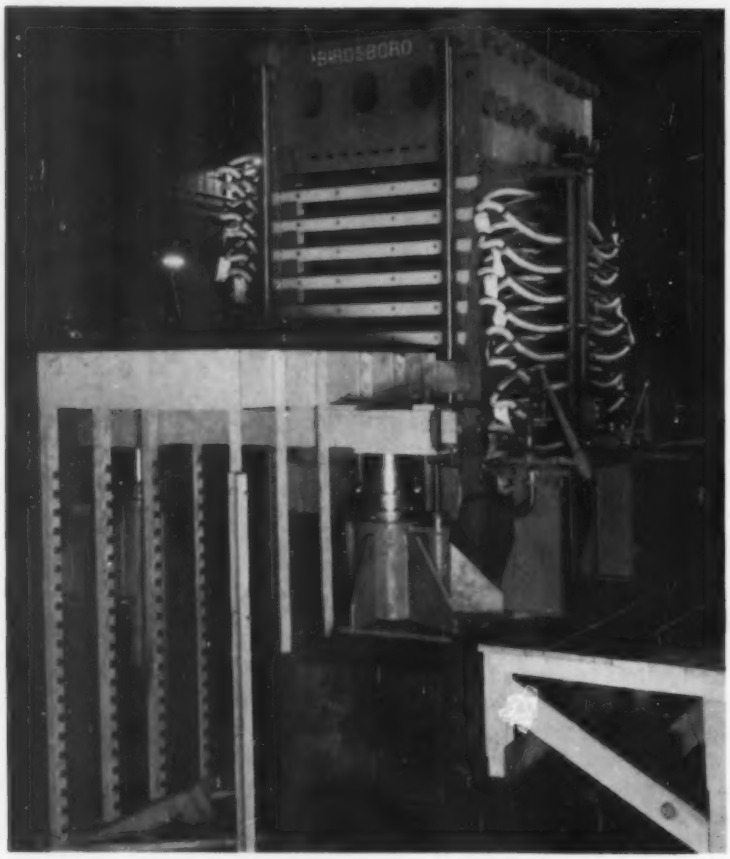
A polypropylene ink cartridge for ball point pens, that looks like brass, has been announced by Keystone Plastics, Newark, N. J. Up to now polypropylene has had only 30% of this market, but with the new brass-colored PP which is one-eighth the cost of brass, a 100% market penetration is expected. Keystone supplies ink cartridges to the pen industry in the U. S. and abroad and was the first to develop and produce this item in 1958. It was one of the first extrusions ever produced from PP in the U. S. Earlier efforts to use polyethylene had been unsatisfactory because of stress crack. The new PP has no such problem and customers seem to prefer the metal "look." Keystone has been an extruder of bristles and ¼- to 2-in. tubing since the end of World War II. The company is a leading producer of cellulose acetate hair curlers which are now said to be the largest-volume curlers on the market. Previous types had big runs in styrene copolymers and vinyl chloride, but acetate is now claimed to be the favorite and the market is big—partly induced by the "Jackie" type hair-do and by the fact that since beauty parlors seem to prefer acetate curlers women believe they have a professional flavor. The curlers are punched, with about 20 holes to a 2¾-in. curler, and thus require special equipment to handle as they come out of the extruder. The holes allow hair to dry rapidly. Acetate is said to be preferred because it is smoother, glossier, and gives a more uniform curl. Another plastic, urethane foam, is challenging for the market but Keystone feels acetate will prevail because it does a better job.

A new cellulose acetate flake

Another interesting item in acetate is Du Pont's announcement of a new acetate flake which permits higher production rates. It is suitable for **(To page 49)**

Unique laminating press elevator shoots production UP, costs DOWN

BIRDSBORO HYDRAULIC



Birdsboro platen press has multiple-opening elevator to speed loading, pressing and unloading.

If you're looking for ways to increase laminating production and profits, this Birdsboro steam platen press is a good place to begin. The 2000-ton hydraulic unit contains a unique multiple-opening elevator. From it, the single operator loads every other opening *during the pressing cycle.* When the press is opened, he unloads the pressed products . . . and reloads the press by advancing the elevator one position only.

Reduced time between pressing cycles and lowered labor costs are two specific advantages this combination delivers to laminators. Just write: *Sales and Engineering Departments:* Reading, Pa. *Manufacturing Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

HP 50-61

BIRDSBORO CORPORATION BIRDSBORO, PENNSYLVANIA

STEEL MILL MACHINERY • HYDRAULIC PRESSES • CRUSHING MACHINERY • SPECIAL MACHINERY • ROLLS • ELECTRIC STEEL CASTINGS: Carbon, Low Alloy and STAINLESS STEEL

DIVISIONS: MIRAWAL DIVISION • CHEMICAL MACHINERY DIVISION

household items, toys, buttons, tool handles, and heels for women's shoes. Du Pont has entered into a working association with Plastic Materials & Polymers Inc. of Hicksville, L. I., N. Y., for its conversion of the flake into molding and extrusion compounds. The arrangement pertains primarily to technical assistance. PM&P, with manufacturing facilities at Hicksville and Slaterville, L. I., and Franklin Park, Ill., will custom-compound and sell all standard grades.

Company mergers in U. K. follow pattern similar to that in U. S.

Mergers and acquisitions of plastics firms in the United Kingdom, involving producer and processor, were highlighted by the recent acquisition of Metal Box Co. by Shorko. Shorko is owned by an organization jointly operated by Shell Chemical and National Distillers & Chemical Corp.

Shell and NDC formed Shorko about a year ago to produce polypropylene. NDC owns Kordite, a PE and PP film producer in the U. S., and expects to pass on knowledge gained from that operation to the new joint venture, which will specialize in oriented PP film and will begin operations in early 1963. Metal Box is a major producer of PE film and blown bottles with wide experience in processing and marketing plastics materials.

ICI acquires film producer. Imperial Chemical Industries Ltd. and E. S. & A. Robinson (Holdings) Ltd. of Bristol have combined to form a new subsidiary, called Robinson Plastic Films Ltd., to produce plastics films for the packaging industry. Robinson is acquiring a minority interest in British Visqueen Ltd., which is an ICI subsidiary. British Visqueen, a PE film producer, was formed originally with ownership divided into one-third Visking of the U. S. and two-thirds Union Carbide. When Carbide bought Visking about 1958, British Visqueen was acquired by ICI.

Mobil buys molder. Another interesting transaction in England was the purchase of 90% of the stock of O. & M. Kleeman Ltd. in England by Mobil Oil Co. of the U. S. for about $20 million. Kleeman operates Erinoid, a major molder, among other properties.

Polyethylene price drop in England

ICI has dropped the price of conventional PE molding-grade resin to what amounts to 21¢ in American currency—film-grade was reduced to 22 cents. In a statement accompanying the announcement the company said: "These new prices which, grade for grade, are equivalent to those of any overseas producer, will enable British converters to meet increasing competition from importations of low-priced goods."

It is believed that the price reduction was aimed more at imports from European countries than from the U. S., although some American resin producers constantly complain that their competitors are selling in Europe for less than 20 cents.

There is as yet no indication that European PE can compete in the U. S. on a price basis with domestic resin—the tariff, including *ad valorem*, is 39%; this means that a 20¢ resin in Europe would have to sell for around 30¢ here, with freight and commissions still to be accounted for. It **(To page 51)**

can these properties solve your process problems?

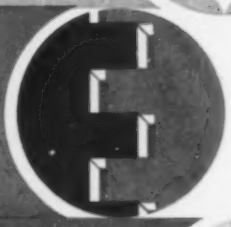
Do you need USP or NF vehicles because your plastics come in contact with food? Are you looking for plastic films with improved toughness and flexibility... or stabilizers for clear formulations? How about a stabilized catalyst for urethane foams? These chemicals from the Witco Group may have the answer to your problem.
For further information write to Technical Service Dept. P-220.

from Sonneborn

WHITE OILS· Sonneborn's USP White Oils function as compressor lubricant, catalyst carrier, plasticizer, dust-reducing agent, colorant vehicle, internal lubricant, mold release and annealing agent. Write for bulletin: White Mineral Oil For Use In The Plastics Industry.

from Witco

METALLIC STEARATES· Choose mold release agents and internal lubricants from the broadest line of stearates available in the U.S. Witco stearates promote smooth processing, facilitate extrusions, increase flow rate into molds and gel PVC plastisols.

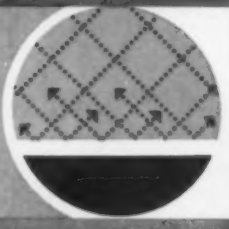


from Witco

ESTER TYPE PLASTICIZERS· Esters of fatty acids and dibasic acids for use as plasticizers and mold release agents; impart flexibility and surface lubricity to finished products; and facilitate easy processing.

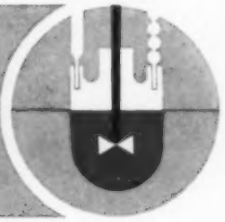
from Witco

STAYRITE® VINYL STABILIZERS· Heat and light resistant properties of Stayrites® counteract degradation effects in clear and opaque PVC formulations. A broad selection of stabilizers and synergists are available.



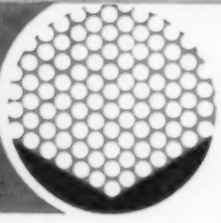
from Witco

PHTHALIC ANHYDRIDE· Used in manufacturing plasticizers, unsaturated polyesters and alkyd molding compounds, phthalic contributes toughness and durability to finished products. As a curing agent for epoxy resins it also increases pot life.



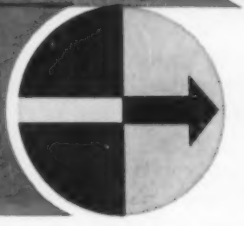
from Witco

CHEMICALS FOR URETHANES· For uniform cell structure, easy processing and foam reproducibility look into Fomrez® polyether and polyester resins, Fomrez® resin for urethane elastomers, Fomrez C-2 stabilized stannous octoate catalyst and Witco 77-86 coupling agent.



from Witco-Continental

CARBON BLACK· Witcoblaks® are effective pigments and fillers for most resins. In PE they provide stabilizing action against the effects of sunlight and weathering.



SONNEBORN CHEMICAL AND REFINING CORP.
Division of Witco Chemical Company, Inc.

WITCO CHEMICAL COMPANY, INC.
122 EAST 42nd STREET
NEW YORK 17, NEW YORK

is also interesting to note that Americans generally tend to believe that an 80- to 100-million-lb. plant is far more economical than anything under that size. In Europe only ICI, with over 100-million-lb. capacity, comes near that mark—the European market supposedly isn't big enough for plants of that size. But a small American plant with a good captive market will soon be under way and if this proves successful and is followed by others, look out for trouble. Over-capacity will be unbelievable and prices will crackle furiously.

Packaging firm moves into plastics

The acquisition of Expandable Plastics Corp., Akron, Ohio, by the Packaging Corp. of America, Evanston, Ill., is a good example of the ever-increasing tendency of packaging firms to move into plastics in one way or another. Packaging is a big industry but there is little doubt that a big portion of its forward impetus in the last decade owes its stimulus to plastics materials. The movement of paper companies into plastics is now more common than it is unusual.

PCA now owns four plastics molding plants. The other three are: Worcester Moulded Plastics Co., Worcester, Mass., which entered plastics molding in 1938, was acquired in 1961; the plastics division of Lakeside Mfg. Co., Milwaukee, acquired in January 1961; and a third plastics facility now in operation at Vincennes, Ind., where, with the company's corrugated container plant, it is the center of a concentration area for furniture, appliances, and electronics that use corrugated containers for outer packaging and molded polystyrene foam as inner cushioning. These four plastics plants have built most of their own molding equipment for foam and their combined volume makes PCA the largest producer of molded polystyrene foam for packaging in the U. S. The tradename of this molded foam is "Mold-Pak." Worcester is the only one of the four that will continue in custom injection molding of other plastics products—the others have dropped their former names and will concentrate on molded polystyrene foam. Horace Gooch, former president of Worcester and now a vice-president of PCA, is in charge of plastics operations.

PCA was formed in July 1959 by merging the facilities of three old-line packaging firms, American Box Board Co., of Grand Rapids, Mich.; Central Fibre Products Co., Quincy, Ill.; and Ohio Box Board Co., Rittman, Ohio. Since then it has acquired the plastics operations named above plus a 52% interest in Tennessee River Pulp and Paper Co., and thus will acquire a proportionate share of that company's new Corence, Tenn., mill that will turn out 170,000 tons of kraft liner board a year.

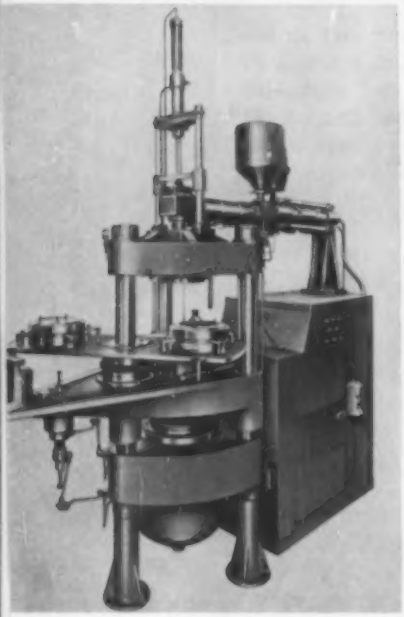
Some idea of PCA's size and importance in packaging can be gleaned from the following information as related in the company's annual statement. It operates 51 production plants, including 22 container plants with total sales last fiscal year of $61,431,000, or 45% of the company's total revenue; ranks seventh in U. S. in paperboard production with eight mills; is tenth-largest producer of corrugated board; has 10 folding carton plants with printing equipment to rank as the third-largest producer; has three molded pulp products plants for packaging of poultry, eggs, meat, etc., including enough packaging material to ship more than 8½ billion eggs in one year.

For additional and more detailed news see Section 2, starting on p. 254

NEW MACHINERY-EQUIPMENT

Specifications, claims made, and prices appearing in these pages are those of the manufacturers or sellers of the machinery and equipment described, or their agents.*

Rotary platen injection machine



Designated the Plastiniector V.850 S., this vertical-clamp, reciprocating-screw injection machine is especially useful in applications requiring molded-in-place inserts. Two mold stations on a rotating swing table are used so that one mold may be loaded with the inserts while the other is in the clamping position receiving the injection shot. The outboard loading position is also equipped with an hydraulic ejector to facilitate removal of finished parts. After the loaded mold is automatically moved into the molding position, it is clamped hydraulically by the clamp ram which can exert a force up to 570 tons. Maximum travel of the movable platen is 13.8 in. (350 mm.); maximum opening between the platens is 23.6 in. (600 mm.). Molds up to 27.6 in. (700 mm.) square can be mounted; maximum moldable area is 246 sq. in. (1590 sq. cm.). The ejector travel is adjustable from 1.18 to 4.72 in. (30 to 120 mm.). Injection capacity is 52 cu. in. (850 cc.); injection pressure is adjustable from 5700 to 17,100 p.s.i. (400 to 1200 kg./sq.cm.); and injection temperature is adjustable to a maximum of 660° F. (350° C.). Typical production on metal-cored auto steering wheels is one unit every 80 sec.—about a 40% reduction in cycle time over presses previously used, due to facilitated loading of metal inserts. *Made by G.B.F. Costruzioni Meccaniche (Bresso, Mi.). Sole selling agent: Covema S.R.L., Via Fontana I ilan, Italy.*

PE bottle flame treaters

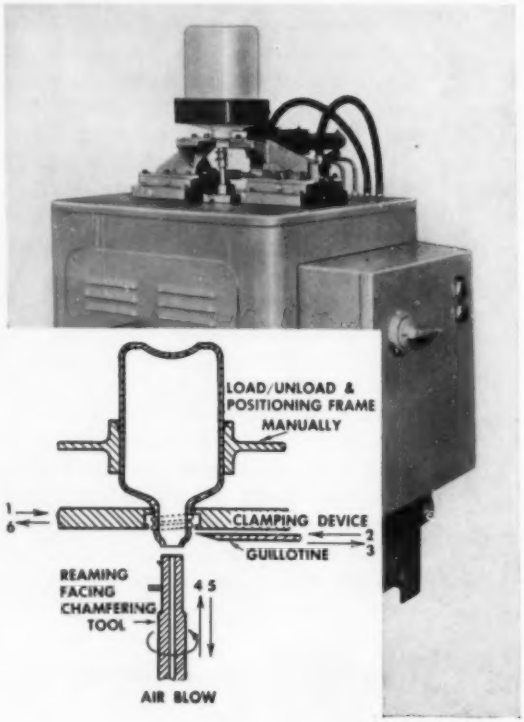
The Model 45 treater will handle cylindrical, oval, conical, and flat containers; cylindrical and conical containers are rotated during flaming. The bottles are placed over square mandrels which are designed with a springing arrangement to accommodate different bottle finish diameters and to insure proper alignment of the bottle during treatment. Burners are arranged to track the bottle for a distance of about 24 in. as it passes through the machine at speeds between 40 and 80 ft. per minute. Bottles are automatically ejected from the machine after treatment. Unit is said to process up to 3000 units/hr. and maximum gas consumption is rated at 50 cu. ft./hr. at a pressure of 4 in. of water. Another unit, Model 46, differing in the method of transporting the bottles past the flames, is said to process up to 4000 or more units per hour. Made in France, the unit is marketed by *Dubuit Ltd., 8 Chase Rd., London N.W.10, England. Canadian Agent: Scott's Screen Process Supplies Ltd., 696 King St. East, Hamilton, Ontario.*

Ultrasonic transducer

For use in ultrasonic film sealing equipment, these transducers are of a new geometrical design which permits them to be bolted, through the middle, to focussing horns and sealing tools. Of the piezoelectric type, made of a lead zirconate titanate ceramic, the units are designed for service up to 300° C. Standard units are stocked for frequency applications from 10 to 100 kc.; special units up to 2 mc. are available on special order. Crystals will be machined to within one cycle of the frequency desired. Electrical connections are by means of solderless lugs. The ultrasonic transducer is supplied with built-in cooling fins. *International Ultrasonic Inc., 331 Centennial Ave., Cranford, N. J.*

Bottle finisher

The Model BFM-1 bottle finisher is designed for applications where bottles require finishing to length, reaming or chamfering of the opening to close tolerances, and fine finish. Bottles are loaded and unloaded manually, while operation is automatically cycled by a foot switch. Tooling is designed so that air may be blown through the center in advance of the cutting edges so that air flows out of the bottle and prevents chips from entering. Automatic cutting cycle is 1 second. (See diagram below.) Unit will handle bottles with necks up to 2 in. in diameter and require air at



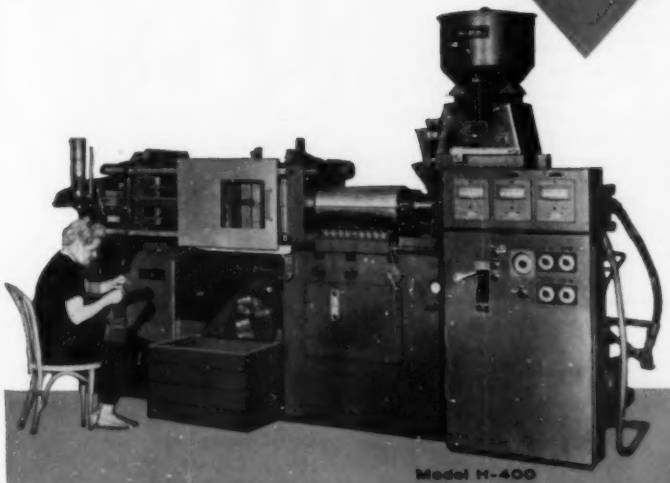
* Prices are deemed to be F.O.B. sellers' plants (unless otherwise stated), are for "standard" models, and are subject to change without notice. The publishers and editors of **Modern Plastics** do not warrant and do not assume any responsibility whatsoever for the correctness of the same or otherwise.

"COMPLETE AUTOMATION"

Prominent toy manufacturer operates their fully automatic Van Dorn 3 oz. presses 24 hours per day, 6 days per week. They also report their Van Dorn presses substantially reduce cycle time, are economical, versatile, and require minimum maintenance.

Model H-300

GAIN 3 WAYS with VAN DORN Presses



Model H-400

Model H-260

"PACKAGE SERVICE"

The user of this Van Dorn 4-6 oz. press had a well conceived idea for a plastic part, but no molding experience. So they had Van Dorn engineers help them procure a well designed mold from a competent moldmaker; then checked the operation of the finished mold on a Van Dorn factory demonstration unit. This free Van Dorn "Package Service" insures satisfaction, helps produce profits.

"25% LESS CYCLE TIME"

This is the report of a progressive custom molder about his Van Dorn 2½ oz. presses. He also says that they "give fast set-ups, and less waste in purging from one material to another. Van Dorns are extremely fast, versatile and economical."

Write for Illustrated Specification Bulletins on these Van Dorn Plastic Presses.

Van Dorn

THE VAN DORN IRON WORKS CO. • 2685 EAST 79TH STREET • CLEVELAND 4, OHIO

Sales and Service Nationwide In Canada: E. J. Donnelly & Assoc., Ltd., Toronto, Ontario

Specifications and claims are those of the manufacturers and/or their agents.

5 cu. ft./min. and 80 p.s.i., using a ½-in. pipe connection. Standard unit does not include guillotine cutting blade, reaming and chamfering tool, or loading-positioning fixtures or clamping plates. These are designed for specific requirements and are available at extra cost. *The Producto Machine Co., 935 Housatonic Ave., Bridgeport 1, Conn.*

Perforating machine

This machine is designed to perforate plastic film and sheet on a production basis, to make them breathable or porous, for example. Film passes between two rolls, one a bed roll, the other carrying needles of the desired perforating design. Minute holes can be put in films on a continuous basis. The machine is made in roll widths of 33, 48, and 60 in., with various needle spacing patterns. Pins are alloy steel, heat treated for long wear, and are replaceable if worn or broken. Standard machine comes with variable-speed drive. *Robert A. Main & Sons Inc., 333 W. Main St., Wyckoff, N. J.*

Slat expander

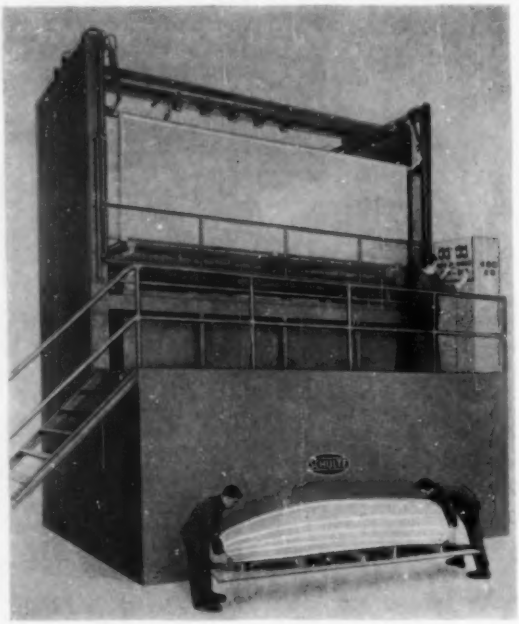
Kay Anti-Wrinkle slat expanders for film processing are composed of shaft bearings, cams, tube, slide, and slats. The expanders are 5 in. in diameter, and are equipped with 1¼-in.-diameter shafts. The shaft is stationary, the slat tube rotating about it on ball bearings. The face of the expander is usually made about 4 in. wider than the maximum width of the web being used. Some sizes are available from stock. *Kay Machine Co., 132 Paterson Ave., P. O. Box 78, E. Rutherford, N. J.*

Specialized injection machine

The Rotojet injection machine is a rotary, eight-station unit suitable for the production of small items. Models T5, T12, and T25 can be fitted with an unscrewing device which allows the molding of threaded items such as bottle caps, etc. This is done by a mechanical system which rotates the molds to free the threaded piece. A screw extruder is used for plastication. Melt passes to an injection chamber where a conventional ram injects the material into the mold. Injection capacity of the largest machine (Model T25) is 1.55 cu. in. per shot per mold. *Conapac Corp., Div. of Roto-American Corp., 120 E. 13th St., New York 13, N. Y.*, U. S. representatives for *Laroche Frères, 46, Rue des Marais, Paris 10e, France.*

Extra-large vacuum former

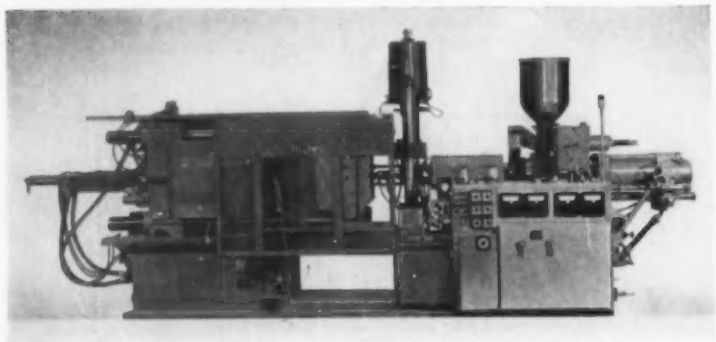
Said to be the largest vacuum-forming machine in the world, the Schulte Model GS 94 is designed for the continuous operation of both vacuum- and pressure-formed parts with weights up to 141 pounds. Molding area is



about 60 sq. ft.; units with working areas up to about 80 sq. ft. are also available. In addition to forming operations, the unit may be used to laminate plastics to other parts. For example, an old rowboat, 11 ft. long, 2.6 ft. deep, and 4.6 ft. wide, was coated with a plastic film 3 mm. thick. Typical production rates range from 10 to 25 cycles per hour. The unit weighs 14 tons. *Schulte-Maschinenbau GmbH & Co., P. O. 7607, Düsseldorf 1, Germany.*

Plastisol deaerator

Dipped, cast, and coated parts made with plastisols can be made blemish-free by removing occluded air prior to application. The Squire-Cogswell deaeration unit consists of a vacuum tank in which the plastisol is showered downward and "scrubbed" of air. Unit comes complete with vacuum pump (40 cu. ft./min., ultimate vacuum of 5 mm. Hg or less), overflow trap with vacuum shut-off, and vacuum tank with liquid distributor. Not included are tank legs (made from iron pipe), material intake line, feed tank, discharge line, or collecting tank. Capacity of the tank is 500 lb., or 55 gal., of plastisol. *Squire-Cogswell Co., 4151 N. Kedzie Ave., Chicago 18, Ill.*

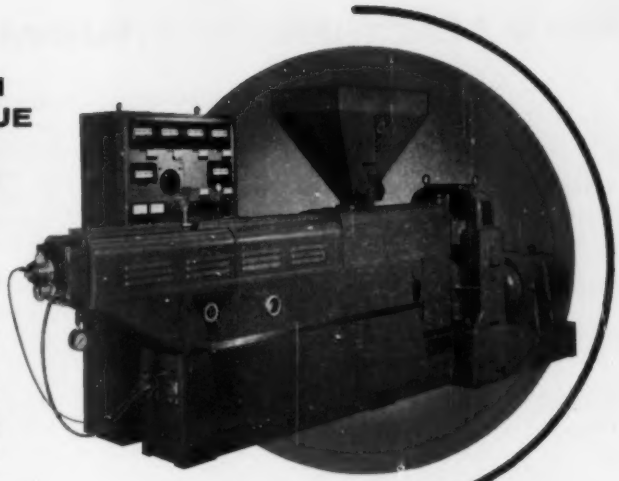


Injection machine

The Fellows Model 12-450 injection machine will dry-cycle at the rate of 600 to 800 cycles per hour. Capacity rating is 12 to 20 oz. with standard prepack which double-strokes the plunger during press dwell. Equipped with the Fellows Transfer Injector unit (which is optional equipment), the unit will produce parts weighing up to 50 ounces. Maximum mold size is 27 by 34 in.; mold locking force is 450 tons; mold opens 10 to 20 in.; power rating is 40 hp.; and heater

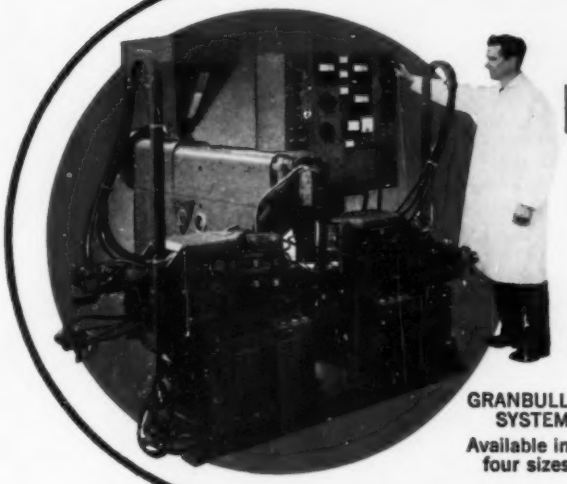
Years Ahead!

PRODEX HIGH TORQUE EXTRUDERS with CHANGE GEARS



now permit you to select quickly the optimum reduction ratio and screw speed necessary to extrude **either high or low viscosity materials** at maximum horsepower efficiency and highest possible production rate for each extrusion job.

Prodex extruders give you the best possible machine return on your investment of any extruders in the world today. These machines are built vented or non-vented in a complete range from 1¼" to 10".



GRANBULL SYSTEM
Available in four sizes

PRODEX FULLY AUTOMATIC BLOW MOLDERS

For small parts—up to 2 gal.—a toggle clamp mechanism is used to develop high pressures and high speed action. A continuous parison flow from a single head feeds up to four mold clamps, resulting in extreme uniformity of parts. The highly streamlined head permits use with all polymers, including rigid PVC.

For large parts—5 to 55 gal.—an accumulator system allows fast extrusion of large parisons, with precise shot metering and uniform temperature throughout the parison prior to blowing.

Prodex blow molders, for maximum output and reliability of operation, are supplied with specially designed, high-performance **Prodex extruders.**

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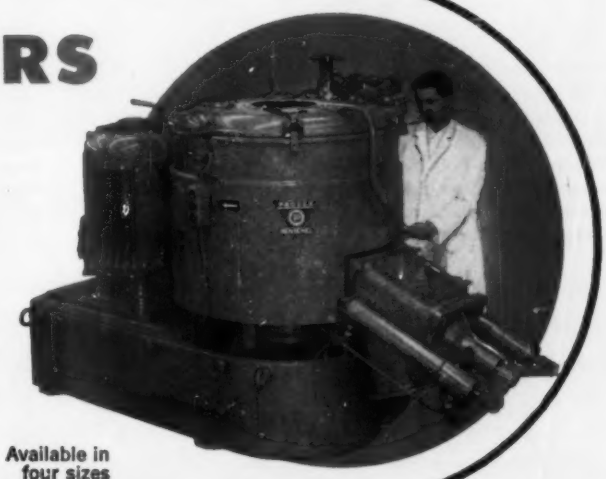
Both laboratory and high production units are now available with capacities from a few lbs. to thousands of lbs./hr. • They can be cleaned quickly and easily. • All contacting surfaces are stainless steel. • Vacuum tight construction is available for vacuum extraction. • Loads and discharges while running.



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unit is 21.5 kw. Plasticating capacity is rated at 150 lb. per hour. *The Fellows Gear Shaper Co., Plastics Machine Div., 78 River St., Springfield, Vt.*

Rotating extrusion die

Designed for the production of tubular blown film, this die is constructed to allow the upper die lip to rotate with respect to the lower die lip. The side exit of the extruded film permits the extrusion of heavier-gage films and the use of higher blow-up ratios. The rotation of the die eliminates the occurrence of lumpy, uneven rolls, since any

gage non-uniformity in the film is traversed across the web resulting in a compensation for gage irregularity when the film is wound into a roll. Through the production of flat, even rolls, the distortion of the film product is eliminated. An adjustable restrictor behind the land is used to build up die pressure, thus promoting uniform flow and the minimization of weld lines. *Sterling Extruder Corp., 1537 W. Elizabeth Ave., Linden, N. J.*

Web saturator

This type of equipment can be used for the production of resin-saturated laminating papers and similar applications. Designed for easy cleaning and roll removal, the Waldron Two-Roll Saturator has a trunnion-mounted, air-actuated bottom roll. The air cylinder rod is booted to prevent sticking and moves the lower roll to preset taper wedge stops; the stops set the gap between the rolls for squeeze-roll saturation. The two-roll trunnion-type saturator replaces the older slide-type machine. The unit is available in web widths up to 120 in., and accommodates precision-ground, chilled-iron rolls with diameters proportioned to the width of the machine. *Waldron-Hartig Division of Midland-Ross Corp., Box 791, New Brunswick, N. J.*

Granulator

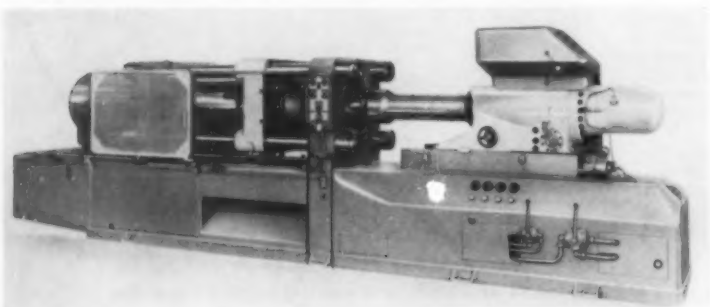
This Dreher cutting mill—the S. 42/65—for the granulation of plastic scrap, has a throughput of 0.5 to 1 ton/hr. depending on the type of material being processed. The throat size is 29.5 by 20.5 in., and the rotor is 16.5 in. in diameter and 25.5 in. wide. The rotor turns at 650 r.p.m. and is driven by a 38- to 60-h.p. motor. There are six rotary and two stationary blades. Mesh screens have been located in relation to the rotary blades in a way aimed at keeping heat generation at a low level and at the production of granules of uniform size. The machine top can be released and tilted back and the cutter patch swung away. Unit is designed for easy-to-clean and safe operation. *Baker Perkins Granbull Ltd., High St., Kingston-on-Thames, Surrey, England. U. S. Agents are Baker Perkins Inc., 1000 Hess St., Saginaw, Mich.*

Mixer-dispenser

Up to 60 shots/min. are possible with this two-part resin and catalyst electro-pneumatic portable mixing and dispensing unit, developed for the rotational molding of polyurethane articles. Shot size may be adjusted from 10 g. to 32 oz., in ratios from 10:1 to 1:1. Resin and catalyst drums are topped by an eight-position turret valve for rapid changing and dispensing of the materials required in multiple-cavity molds. Both drums and connecting hoses can be heated to any required temperature. The unit, 4 by 2 by 6 ft. high, is portable and may be adjusted to optimum working positions. *Akron Presform Mold Co., 2038 Main St., Cuyahoga Falls, Ohio.*

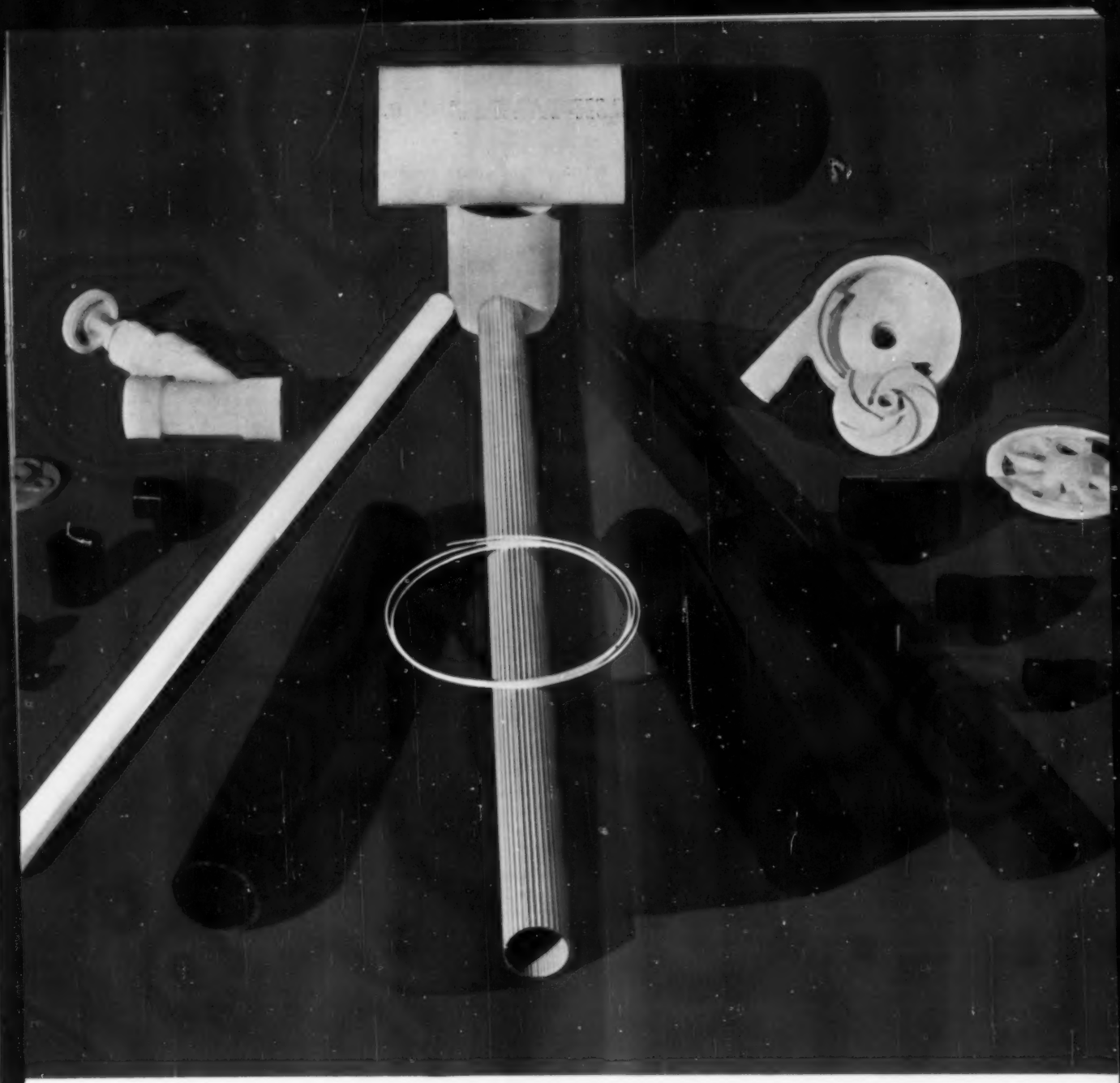
Tube marker-cutter

Designated Model ETMA, this tube marking machine automatically feeds, marks, and cuts to desired length all types of flexible plastic tubing. A dry imprinting system eliminates the drying period required with wet ink systems. Production rate can be varied from 60 to 190 pieces/min., depending on tube size and length. Feed is adjustable for markings from ⅜ to 2 in. long. Tubes from ⅛ to 1 in. O. D. may be processed. Pressure is precisely adjustable. Cutters have replaceable carbide cutting faces. Machine stops automatically after a preset number of parts has been produced. Temperature is adjustable from 200 to 600° F. *The Acromark Co., 5-15 Morrell St., Elizabeth 4, N. J.*



Injection machine

The Model 1/100/350 Preplastmatic reciprocating-screw injection machine is now available in a new version. The machine has a nominal shot capacity of 1000 g. (approximately 35 oz.) and a plasticating capacity of 220 lb. per hour. Clamp force is 385 tons on a $29\frac{17}{32}$-in. stroke. Maximum daylight between the platens is 47¼ inches. Platens are $35\frac{7}{16}$ in. square with $21\frac{17}{64}$ in. between the tie bars. The



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injection unit of the machine may be rotated away from the platens to permit easier access to the injection cylinder for maintenance purposes. *A. Triulzi S.A.S., Via Vialba 56, Novate, Milan, Italy.*

Cut-off saw

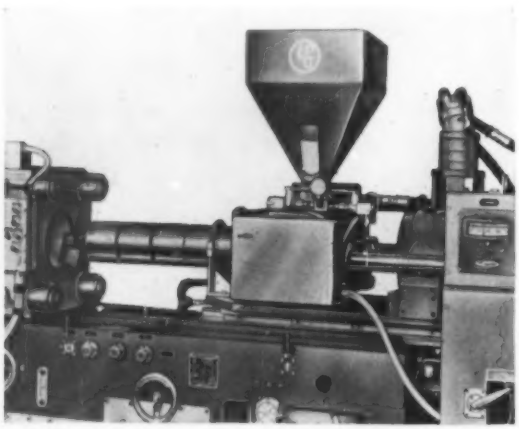
The Emery P. S. 14 automatic, traveling table cut-off saw is designed for use in the continuous extrusion of plastic pipe and other profiles. Equipped with a 14-in. circular blade and powered by a 1-hp. motor, the saw can automatically cut shapes or pipe up to 4⅞ in. in height or in diameter and flat material up to 12 in. wide with ⅛-in. accuracy. Production cutting is up to 60 ft./min., and the saw cycles automatically to provide up to 30 cuts per minute. Table height is adjustable to suit a wide variety of forming or extrusion equipment. Working surface is scribed with register line to facilitate set-up. Price: $1895. *The Vern Emery Co., 10647 Wixom St., Sun Valley, Calif.*

Heated dispenser

These heated, overhead-mounted dispensers can be used for the handling of thermoplastic melts and high-viscosity resins in pouring operations. The unit is hung on a sling and equipped with two handles for controlling the dispensation of the contents. A lever on one of the handles opens and shuts the pouring spout. The bottom and 75% of the sidewalls are heated with a blanket-type heating element. Wall temperatures are thermostatically controlled. Units are designed for 115- and 230-v., single-phase power and for temperatures from 150 to 550° F. Other models are available on special order. Small units (2 to 10 qt.) have a cast aluminum inner pot in a spun steel housing. Larger sizes (to 50 gal.) are available with plain or stainless steel inner tanks. *Sta-Warm Electric Co., Ravenna, Ohio.*

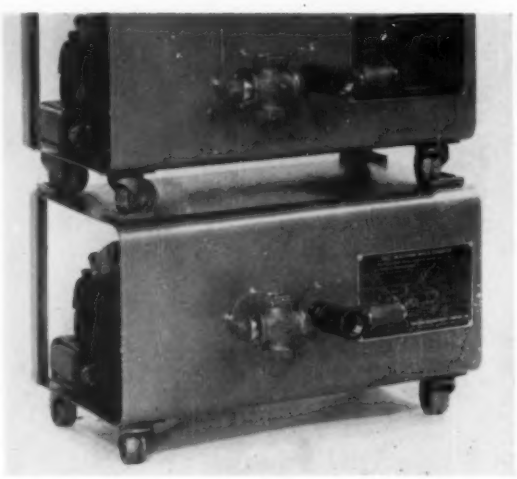
Injection machine

Designated Model 300-14S, this reciprocating-screw injection machine has a nominal shot capacity of 14 oz. (styrene), and a plasticating capacity of 120 lb. per hour. Injection rate is 1200 cu. in./min. using a 2.5-in.-diameter plunger on a 5-in. maximum plunger stroke. Injection pressure is adjustable up to a maximum of 19,000 p.s.i. Screw rotation is controlled by a hydraulic motor drive. Maximum clamp pressure is 300 tons on a stroke adjustable from 6 to 14 in., while maximum die size is 16.5 by 28 in. (V by H). Daylight opening is 32 in., and platens are 25 in. square. Heaters are rated at 12.2 kw., and the machine is equipped with a 25-hp. motor. Standard equipment includes power mold space adjustment; linkage for swiveling injection unit; manual, semi-automatic, and automatic control systems; and heater band burn-out indicators. *Lombard Governor Corp., Ashland, Mass.*



Mold starter

This device is designed for use in molding operations where the injection mold is not run with a mold circulator. The IMS mold starter is placed in the cold water feed line to the mold. When starting up the mold, the unit circulates super-heated water to the injection mold until good parts are being obtained. The starter is then turned off and a 3-way valve is set to allow cold water to flow through the mold in conventional operating fashion. Use of the unit is said to increase production by reducing the amount of startup time required. Units are caster-mounted but can be stacked up to six-high to save floor space. Carried in stock for immediate shipment, complete unit is priced at $298.50. *Injection Molders Supply Co. Inc., 17601 S. Miles Rd., Cleveland 28, Ohio.*



Finishing machine

The Model FWP-40 automatic fill, wipe, and polish machine applies paint and dial fillers at rates up to 2500 parts per hour. Only one operator is needed to load workholders. Loaded parts move to a remote masking station for application of the filler. A smear wipe removes the excess filler while it is wet, promoting an even flow into indentations and eliminating caking and powdering associated with wiping the filler after it is dry. Drying time for the finish wipe is speeded up and force drying may be used. A third station supplies the final wipe and polish. Parts are then automatically ejected from the machine. Unit has self-contained exhaust for solvents. *Conforming Matrix Corp., 830 New York Ave., Toledo 11, Ohio.*

Color blender

Called the Proportionator, this machine is designed to proportion and mix color concentrate with uncolored materials in dry blending applications. A new metering device in the unit is designed to provide for an infinite num-

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BL 65
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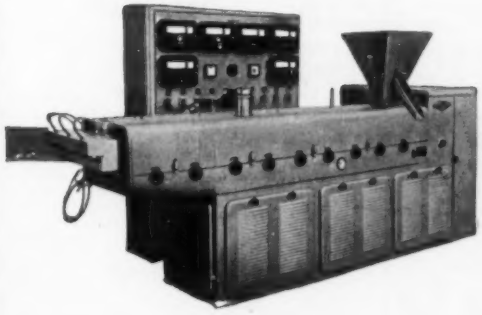

SAMAFOR EXTRUDERS ARE AVAILABLE IN SCREW SIZES OF 1 1/4"- 1 3/4"- 2 1/2"- 3 1/2"- 4 3/4"- 6" - WITH L/D RATIOS OF 20:1 OR 26:1 - AND VENTED OR NON VENTED CYLINDER

TECHNICAL DATA

Screw diameter between 30 and 150 m/m (1" 1/4 and 6")
L/D Ratio : Non vented type : 20:1 - 26:1
Vented type : 26:1 only

REDUCTION GEAR : Horizontal double gear train - helicoid gear cut, allowing smooth running and high working speeds.

FEED SECTION : Cooled by adjustable water flow.

BARREL : One piece made - XALOY - heating by shrouded resistances placed in grooves perpendicular to the barrel generatrix - Cooling by air with manual adjustment. Temperature regulation controlled through a proportioning type heater.

SCREW :
Chromium molybdenum steel - Stellited flight lands - Hard chromium plated flight and flight sides - Cooling by oil flow, regulated within ±2° C. accuracy - Screw types for various materials processing Quick disassembly by front barrel.

HEADS : For all purposes : profiles, tubing, pipes, sheets, tubular film, blow moulding, bottles, bands, etc...
Heads fixed to barrel. by clamp.

REGULATION AND CONTROL CABINET.
Containing the temperature regulators, the motors and heating device contactors. Are fixed on a panel, mounted on shock absorbers for vibrations protection.

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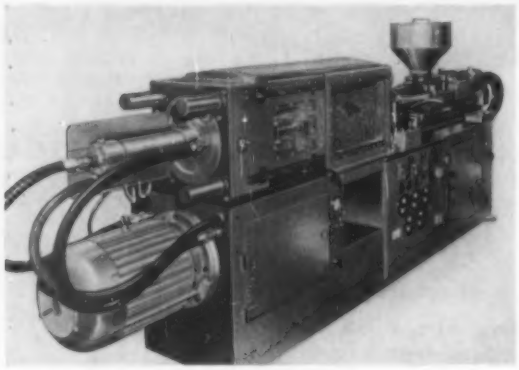
ber of ratios of concentrate to resin. The unit is made in two models, one for mounting on the process machine hopper and one for use with the Thoreson-McCosh Jet Loader. The latter unit is used to load the proportioned mix into the machine hopper. The unit can be adjusted to handle either virgin pellets or granular scrap materials. The device is equipped with a concentrate feed hopper with an approximate capacity of 10 lb., and an uncolored resin feed hopper which will hold about 150 lb. of material. *Thoreson-McCosh Inc., 18208 W. McNichols Rd., Detroit 19, Mich.*

Injection machine

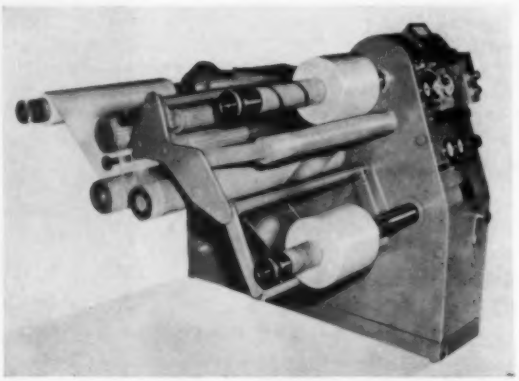
The Windsor SP7 single-screw reciprocating screw injection machine has a shot capacity of 7 cu. in. (about 4 oz. of polystyrene) and a plasticating capacity of 50 lb./hr. using injection pressures up to 17,000 p.s.i. on the material. It will handle molds with projected casting areas up to



40 sq. in., depending on mold and material, with a clamp force of 80 tons. Molds between 6 and 14 in. thick may be used. Press has four tie bars, with diameters of 2.5 in. set with centers 15 in. apart; mold platens are 21 in. square. Heaters consume 5 kw. Plasticating screw speed is variable and is supplied by a completely independent hydraulic drive which operates continuously except on the injection stroke. Upper tie bars may be removed without affecting platen alignment for installing oversize molds and mold height is adjusted by a built-in gear system. *R. H. Windsor Ltd., Leatherhead Rd., Chessington, Surrey, England.*

Film reslitter and doctor machine

For use with polyethylene and other plastic films, the Model 184 Stanford doctor machine reslitter can be used for inspection, slitting, staggered multi-roll winding, single-



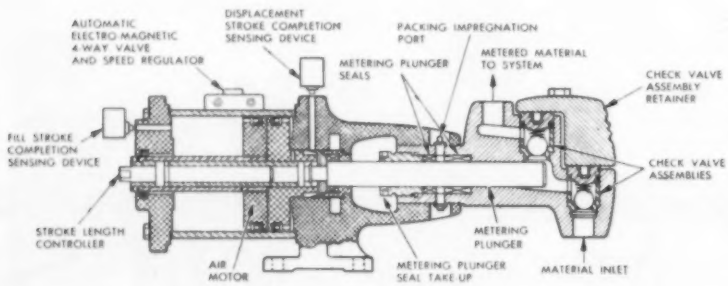
roll winding, or rewinding, and normal roll salvage operations on a continuous and automatic basis. The unit is of an open-end design with cantilevered roll shafts for fast loading, unloading, and web threading. The standard rewind roll diameter is 18 in., and the rewind tension pattern is of the taper-tension type, the tension diminishing as the roll builds up. The unit is powered with a variable-speed electronic drive. Standard web speed is 100 ft. per minute. *Stanford Engineering Co., Salem, Ill.*

Urethane foam dispensers

Suitable for use with most urethane foam formulations, the Model RA-2000 foam dispenser will meter two resin components in ratios from 97:3 to 50:50 at rates up to 3.5 lb./min., handling materials with up to 15,000-cps. viscosity. Unit may be run intermittently or continuously. The manufacturer also offers two foam dispenser-mixer heads, Models RA-12 or RA-101. The former is a frothing-type head, while the latter is designed for non-frothing foam formulations. Capacities are 12 to 40 lb./min. and 3 to 15 lb./min., respectively. Both have variable-speed mixer drives. *Rogers Associates Inc., Box 752, West Caldwell, N. J.*

Pelletizer

The L & P Strand pelletizer has been specifically designed for handling stock as low as 50 to 60 durometer, but will also handle more rigid thermoplastics as well. The unit will process strands up to $\frac{3}{16}$ in. in diameter. Normal cut is $\frac{5}{32}$ in. long. The Model 15 unit is a laboratory size for use with 1½-in. extruders. The Model 20 unit will accommodate the output of a 2½-in. extruder. Larger sizes are available on request. Feed rolls are geared to the cutting blades so that cutting length is constant. Speed range is adjustable. *L & P Tool Co., 2861 Sidney Ave., Cincinnati 25, Ohio.*



Resin mixer-dispenser

The Novo Pneumatic "C" series of two-component metering, mixing, and dispensing units is designed for continuous or intermittent operation. Pneumatic metering elements provide an adjustable component ratio over the range from 1:1 to 2000:1 with an accuracy of 0.5% (volumetric). Hydraulic pressures up to 4000 p.s.i. allow the machine **(To page 194)**

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MINI-JECTORS mold all thermoplastics, including nylon, quicker, better, at low cost.
MINI-JECTORS cost less—models start under $1,000. Mold blanks as low as $29.50.

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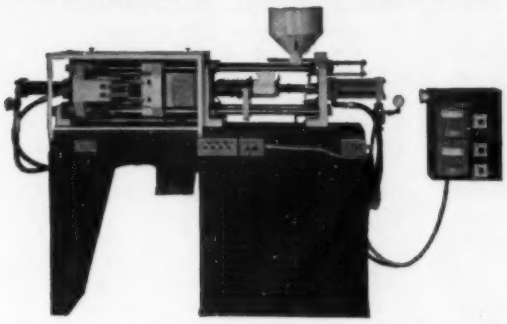

Fully automatic. Up to 2 oz. capacity. Hydraulic. Approximately 42 tons clamping pressure. 8" x 11" mold area. Up to 10 cycles per minute. Interchangeable cylinders. Horizontal clamping 2-zone heating cylinder. Pre-pack stroke—$6,470.

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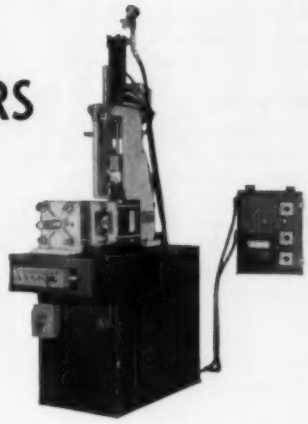
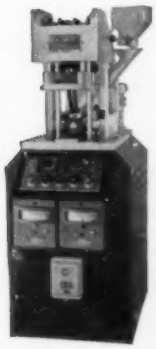


Fully automatic, Semi-automatic, Manual. Horizontal clamping. Capacity to 1 oz. Air or hydraulic. From $1,785 to $3,600.



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Automatic, Semi-automatic and Manual. Up to 1½ oz. capacity. Mold area 6" x 5⅛" x 5". Hydraulic power. Ideal for molding involving inserts or loose cores. $5,400 to $3,385.

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Manual operation. Up to 1 oz. capacity. Air or hydraulic. Uses inexpensive, self-locking "V" molds. Ideal for molding involving inserts or loose cores. From $965 to $2,368.

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WORLD-WIDE PLASTICS DIGEST*

Abstracts from the world's literature relative to plastics. For complete articles, send requests direct to publishers. List of addresses is at end of this section.

General

Organic semiconductors. H. A. Pohl. Electro-Technology *67*, 85-89 (May 1961). The phenomenon of conduction in organic polymers is reviewed in terms of semiconductor theory. Conductivity data for various compounds that have been investigated are cited and future possibilities of practical applications in electronic devices are explored.

Plastics as materials of construction. R. B. Seymour. SPE J. *17*, 148-9 (Feb. 1961). In this review a number of case histories are cited as examples of the use of plastics in construction. Among the most important fields of use are building, transportation, and corrosion-resistant applications.

Materials

Thermomechanical investigation of copolymers of polydiphenylsiloxane-ethylene fumarate and styrene. M. A. Bulatov and S. S. Spasskii. Vysokomolekuliarnye Soedineniia *3*, 208-12 (Feb. 1961). By reaction of diphenyldiethoxysilane with low-molecular polyethyleneglycol fumarate, an unsaturated polyester, containing diphenylsiloxane chains in the backbone is obtained. The incorporation of silicon in the form of difunctional units in the polyester chain lends elasticity to copolymers of the polyesters with styrene. The elastic deformation is minimal in copolymers approaching an azeotropic composition. The nature of the hydrocarbon radicals at the silicon atom does not affect the relative activity of the fumaric bond in the copolymerization reaction with styrene.

Phenolic-nitrile rubber copolymers. G. R. Sprengling and E. J. Traynor. J. Appl. Polymer Sci. *5*, 100-03 (Jan.-Feb. 1961). Nitrile rubbers are often used together with phenolic resins in molding materials to produce an impact-resistant product. These mechanical mixtures may react during final cure. Acrylonitrile-butadiene rubbers containing residual unsaturation, however, can be coreacted with phenolic resins during the early stages of polymerization if appropriate conditions are adopted. The coreaction products are completely soluble in alcohol, whereas the rubbers are not. Laminates made from these coreaction products are flexibilized to the point at which they lend themselves well to cold punching. Yet the rubber, being tightly bound, cannot be extracted with solvents nor lead to blistering on heating.

* Reg. U.S. Pat. Off.

Molding and fabricating

Blowing of polyethylene bottles. W. R. K. Wilson. Kunststoffe *51*, 158-63 (Mar. 1961). The weight of a blown bottle influences its quality as well as its manufacturing costs. Since polyethylene bottles are being increasingly used as containers for detergents and the like, the stress-cracking resistance of such bottles is of considerable importance. In an exhaustive series of experiments the effects of physical properties and die diameter on expansion of the blown tube were determined, as well as the effects on stress-cracking resistance. It is of considerable importance to have a ratio of 1.2:1 for bottom diameter: length of seam.

Properties

Optical properties of transparent corrugated sheets. V. Zvonar. Kunststoffe *51*, 145-50 (Mar. 1961). Since the introduction of corrugated glass fiber reinforced polyester sheet, the light transmission has increased considerably. The limit of transparency is determined by light losses due to reflection at the surface. To ascertain this limit, the reflecting characteristics of several types of corrugated sheet were considered theoretically. Light loss is determined not only by refractive index and angle of incidence but also by the actual form of the corrugated sheet. The best corrugated sheet made on a commercial scale is that which has an arc profile. Even in this case at least 5 to 11% of the light is lost because of reflection.

Effect of polymerization catalysts on the degradation rate of isotactic polypropylene. D. Rysavy and L. Balaban. Vysokomolekuliarnye Soedinenii *3*, 470-74 (Mar. 1961). The influence of the catalysts used during polymerization on the stability of isotactic polypropylene was studied. The catalytic system $TiCl_3$—$AlEt_3$ in its active form strongly accelerates degradation of the polymer at 200° C. Catalysts deactivated in air or methanol do not affect the degradation in inert media. In the presence of oxygen, however, they markedly influence the stability of the polymer, as well as of the polymer compounded with an antioxidant.

Testing glass-fiber-reinforced plastics. G. Niederstadt. Kunststoffe *51*, 191-95 (Apr. 1961). Mechanical properties are frequently determined using specimens that are subjected to a combination of stresses. Since these influences are normally not taken into account in testing, it follows that sharply defined material properties are not obtained. Where combined stresses are unavoidable, determinations will give only comparative values. Such values should never be used for design criteria.

Testing

Applications of gas chromatography to polymer analysis and characterization. A. Barlow, R. S. Lehrle, and J. C. Robb. Polymer *2*, 27-40 (Mar. 1961). Two techniques of polymer degradation were independently incorporated into a conventional gas chromatography apparatus, so arranged that the carrier gas sweeps the degradation products directly into the analysis column. The method involving pyrolysis on a filament is versatile, since any temperature up to 1000° C. may be selected for the degradation. The chromatogram series for a given polymer at a number of temperatures gives a rapid and unambiguous characterization of the polymer. Quantitative measurements on the chromatograms of copolymers and polymer mixtures enable their composition to be determined with an accuracy better than 2 percent.

Assessment of cure of resin. Plastics *26*, 109-15 (Feb. 1961). A survey of various methods of determining the cure of thermosetting resins is made. An abridged version of a report on these methods by a standards committee is presented.

Publishers' addresses

Electro-Technology: C-M Technical Publications Corp., 205 E. 42nd St., New York 17, N. Y.

Journal of Applied Polymer Science: Interscience Publishers Inc., 250 Fifth Ave., New York 1, N. Y.

Kunststoffe: Karl Hanser Verlag, Leonard-Eck-Str. 7, Munich 27, Germany.

Plastics (London): Temple Press Ltd., Bowling Greene Lane, London WC1, England.

Polymer: Butterworths Scientific Publications, 4 and 5 Bell Yard, London WC1, England.

SPE Journal: Society of Plastics Engineers Inc., 65 Prospect St., Stamford, Conn.

Vysokomolekuliarnye Soedinenila: Academy of Science of U.S.S.R., Moscow, Russia.—End

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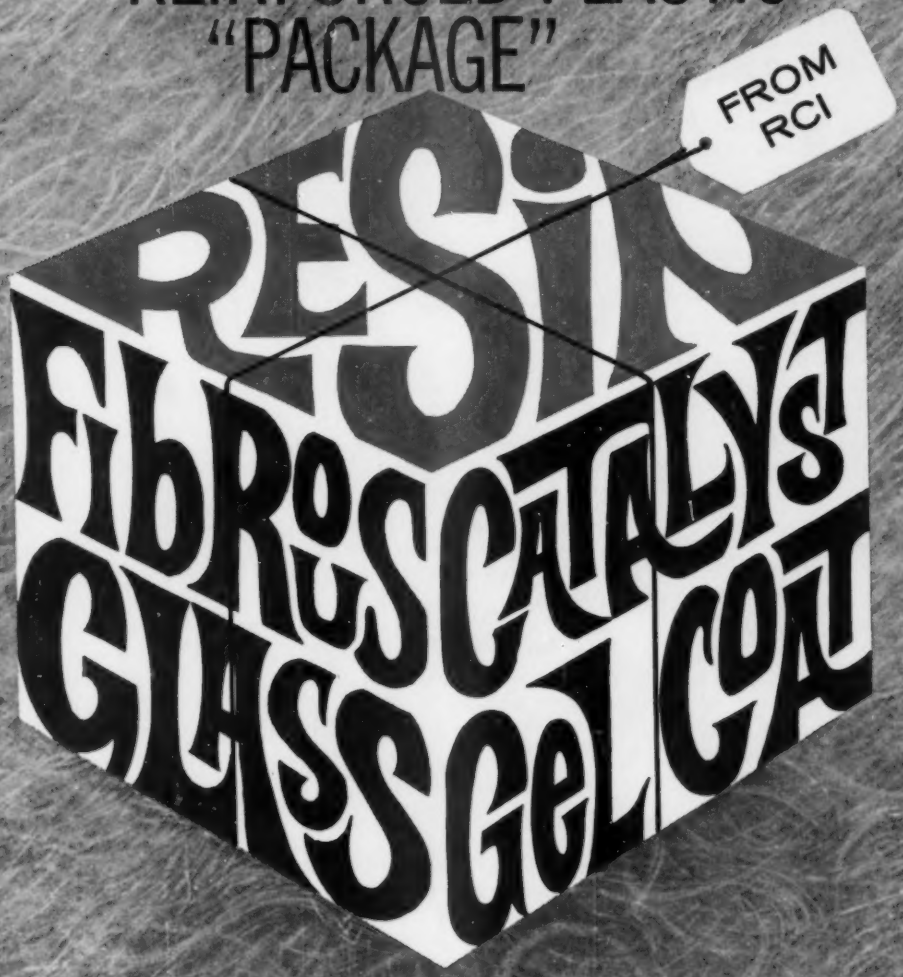

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U.S. PLASTICS PATENTS

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 25¢ each.

U. S. Pats., May 16, 1961

Polyurethane compositions. G. K. Hoeschele (to Du Pont).
2,984,645.

Styrene-acrylonitrile copolymers. F. V. Williams and R. A. Ruehrwein (to Monsanto).
2,984,648.

Styrene - acrylonitrile - methacrylonitrile terpolymers. R. J. Slocombe and G. L. Wesp (to Monsanto).
2,984,650-1.

Vinyl alcohol-vinyl ester copolymers. E. F. Jordan Jr., W. S. Port, and D. Swern (to U. S.).
2,984,652.

Azomethine-olefin copolymers. P. J. V. J. Agius and P. R. Morris (to Esso).
2,984,654.

Curing of poly(vinyl methylether). D. C. Kirk Jr. (to Hercules).
2,984,655.

Vinyl alkyl ether polymers. J. Lal (to Goodyear).
2,984,656.

U. S. Pats., May 23, 1961

Oxime-aminoplast condensates. J. A. Blanchette and E. C. Chapin (to Monsanto).
2,985,610.

Norborane interpolymers. N. G. Gaylord and R. T. Dean (to Interchemical).
2,985,611.

Resins with controlled UHF characteristics. J. A. Campbell (to X-Pert Oils).
2,985,613.

Phenolic novolak composition. E. M. Bright (to Air Logistics).
2,985,614.

Unsaturated polyester. R. Tunteler (to Toegepast Natuurweten).
2,985,615.

Epoxy compositions. C. W. McGary Jr. and C. T. Patrick Jr. (to Union Carbide).
2,985,616.

Stabilized perfluorocarbon plastics. F. J. Honn (to 3M).
2,985,620.

Light-stabilized polyamide. J. Brandes and R. Gewehr (to Vereinigte Glanzstoff).
2,985,621.

Cashew nut shell modified epoxy. J. E. Leppert (to Colloid Chemical).
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Formaldehyde polymers. O. Schweitzer and W. Querfarth (to Deutsche Gold-und Silber-Scheideanstalt).
2,985,623.

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2,985,625.

Copolyamides. J. R. Caldwell and R. Gilkey (to Eastman).
2,985,625-6-7-8.

Crosslinking polyacrylonitrile. R. M. Price and A. F. Roche (to Dow).
2,985,630.

Polyacrylonitrile. W. G. Schmidt and J. E. Field (to Courtaulds).
2,985,634.

Polyvinyl alcohol. M. Anselm, J. Smidt, and H. Winkler (to Elektrochemische Industrie).
2,985,636.

U. S. Pats., May 30, 1961

Coloring polyurethane foams. N. L. Anderson and C. E. McGinn (to Allied Chemical).
2,986,536.

Expandible thermoplastics. P. C. Chaumeton (to Shell).
2,986,537.

Methylol-amino-triazine allyl ethers. P. Zuppinger and G. Widmer (to Ciba).
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Coloring vinyl aromatic polymers. A. W. Jefts and H. G. Rotherham (to American Cyanamid).
2,986,547.

Siloxane resins. J. R. McLoughlin (to General Electric).
2,986,548-9.

Polynuclear epoxides. A. C. Davis and R. F. Hunter (to Bakelite).
2,986,550.

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2,986,551-2.

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Surface-active polymers. W. H. Kirkpatrick, V. L. Seale, A. Walker, and J. B. Love. (to Visco).
2,987,490.

Vinyl - methacrylic copolymer. D. Grady and A. Hodge (to British Celanese).
2,987,493.

Linear polyurethanes. W. B. Black (to Chemstrand).
2,987,494.

Phenolic - butadiene-furfural condensate. M. T. Harvey and P. L. Rosamilia (to Harvel).
2,987,495.

Epoxy resin. J. I. de Jong (to Koninklijke Zwavelzuurfabrieken).
2,987,498.

Polyester - N - vinylpyrrolidone resins. J. Werner and R. Steckler (to General Aniline).
2,987,499.

Graft copolymers. J. K. Rieke and C. Moore (to Dow).
2,987,501.

Polyesters. J. A. Van Allan, G. R. Lappin, and J. W. Tamblyn (to Eastman Kodak).
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Poly-N-vinyl-2-oxazolidone. J. Werner (to General Aniline).
2,987,505.

Crosslinked alkyl vinyl aromatic hydrocarbons. N. R. Ruffing and J. L. Amos (to Dow).
2,987,508.

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2,987,514.

U. S. Pats., June 13, 1961

Shaping high molecular weight plastics. F. Porter (to Allied Chemical).
2,987,766.

Fluid forming. C. E. Berry and M. T. Cichelli (to Du Pont).
2,987,767.—**End**

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Rep's.: H. M. Royal, Inc., 11911 Woodruff Ave., Downey, Cal.; Philipp Bros. Chemicals, Inc., 10 High St., Boston; H. L. Blachford, Ltd., 977 Aqueduct St., Montreal.
European Affiliates: SA Argus Chemical NV; 33, Rue d'Anderlecht, Drogenbos, Belgium—Lankro Chemicals, Ltd.; Salters Lane, Eccles, Manchester, England.

LETTERS TO MODERN PLASTICS

Trade Fair in Moscow

Sir: Having read with interest your special reports of the Interplas and Europlastica expositions and the one of your Ninth National Plastics Exposition in New York, I feel that you may agree that your readers will be interested in another show in which our company recently took part. I have reference to the British Trade Fair held in Moscow, May 19 to June 4 of this year.

We have been doing business with the Soviet Union for about five years and have experienced quite a few of the problems which beset the machine manufacturers in this market. As precision engineers we have tried to show the Russians that we produce the best quality equipment and that we are looking for long-term business relations rather than spectacular opportunist deals. To this end we have paid several visits to Russia, have kept them well-supplied with technical descriptions of our equipment, and have made a film in the Russian language designed for the technicians. We have also made it quite clear to them that visits to our Works for inspection of equipment and technical discussions are always welcome.

There is no doubt that the British Trade Fair in Moscow had the most outstanding impact upon the Russian people both technically and from a public point of view. Many businessmen, I am sure, are aware of the problems with which the Western businessman has to contend in any transactions with the Soviet Union: the frustrations, the negotiations, the hard business dealing, and last, but not least, the very important factor of the expense involved in any private or public exhibitions. There is no doubt in my mind that the British Trade Fair in Moscow has been highly successful and will prove to be the turning point in the whole of our trading relations with the Soviet Union and the Soviet Bloc countries.

One of the essential things in any business dealings with the Soviet Union is, of course, the fact that one's Sales Manager for that particular territory should be a fluent linguist, and there is no doubt that this has aided my own company to the greatest extent in the success that we have enjoyed in trading over the last five years. It is indeed encouraging to learn that a program has been set up for the training of Sales Managers and Technical Service Engineers to speak the Russian language.

In respect to the plastics industry itself, there is no doubt that we are all in a very interesting position *vis-a-vis* the Soviet Union and its chemical industry, for the industry itself is a favored child of the Seven-Year Plan. There is no doubt in my mind that the Russian Government intends to implement their policy of development of the chemical and plastics industry. Within the next 10 years we may well see emerging from the Soviet Union the greatest flow of chemical and plastics products yet seen in Europe. To this extent it is highly important that we all endeavor to maintain the maximum possible trade relations with the Soviet Bloc countries. There is, therefore, no doubt in my mind that manufacturers of plastics machinery have a very good trade to look forward to. Even though plastic raw materials are perhaps not plentiful in the Soviet Union at the moment, with the various negotiations that have been completed for the sale of knowhow and technique for more chemical factories in the production of thermoplastic materials, the future indeed looks very good.

Many of you, I am sure, have visited the Soviet Union and well appreciate the numerous requirements for consumer goods in that country and the natural desire to increase the standard of living. It is obvious that our particular branch of the industry has more than an important part to play in successfully achieving this end—an end which I feel is in the interests of both West and East.

At the British Trade Fair in Moscow our company was the only one to demonstrate injection molding machines; two of our latest models, the SP. 7 and the AP. 30/115, were demonstrated daily to the technicians and the public. We were determined to place before not only the factory managers, technicians, and the Government, but also the public at large, the fact that we had the finest and most up-to-date equipment to offer.

Finally, I would say that the private exhibition we held in conjunction with Imperial Chemical Industries in 1960, without any doubt paid dividends in the sense that the technicians responsible for operating the plastics machinery and the managers in charge of the various plants from all over Russia came to our stand and discussed quite openly their various problems and stated how much they really look forward to being able to have closer relations with machinery suppliers all over the world. This, in effect, was a great break-through and something which we had not believed possible, since it normally takes years to set up good trade relations.

To sum up, one can only say that many things have changed in the Soviet Union. They are determined under their Seven-Year Plan to see that the chemical and plastics industry will emerge as, if not the largest, then one of the largest, in the world in the next 10 years. It is my considered opinion that irrespective of the risk of the copying of any machines or plant (which is a hazard we all have to accept in industry) the greater amount of trade that is done with the Soviet Bloc countries can only lead to better human relations between the peoples of the world. Only from this can stem normalization of the present world situation.

R. E. G. Windsor
Chairman & Managing Director
R. H. Windsor Ltd.
Chessington, Surrey, England

New data

Sir: In my article, "Estimation of long-time performance of extruded plastic pipe from short-time burst strength," which appeared in the May 1960 issue of MODERN PLASTICS (p. 139), a master rupture curve for high-density polyethylene pipe was shown (p. 142). This was drawn from short-term burst data and theoretical considerations developed in a previous article, "Gener..l formula for creep and rupture stresses in plastics" (MPI, Apri[illegible] 1960, p. 127). The master rupture c[illegible]rve did not coincide satisfactory with the long-term data previously published by Richard, Diedrich, and Gaube.

The writer expressed the view that the long-term data were internally in-

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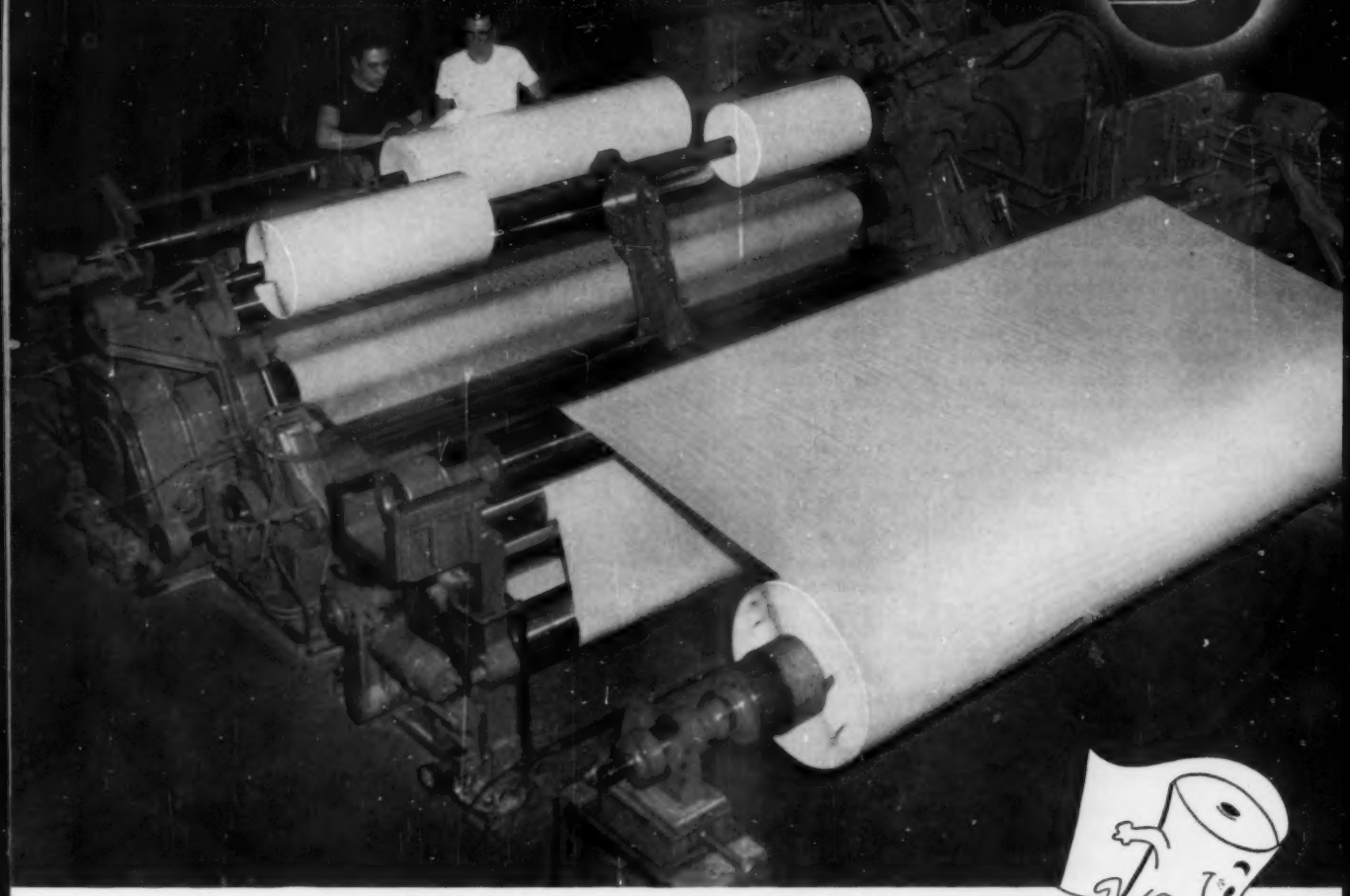

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consistent with respect to at least one temperature because of the uneven spacing of the isothermals. A communication has been received from Dr. K. Richard, Farbwerke Hoechst A.G., Frankfurt, Germany, in which he agreed with this thesis; and, with this in mind, has submitted a group of isothermals (see Fig. 1, below), based on more recent tests.

A new master rupture curve based on the data is shown in Fig. 2. The long-term data are now more congruent with the curve and, in fact, give almost a perfect fit. This has given us increased confidence in the use of short-term burst strength tests in determining the long-term performance of extruded plastics pipe.

S. Goldfein, Chief
Plastics Section
U. S. Army Engineer Research and Development Laboratories
Fort Belvoir, Va.

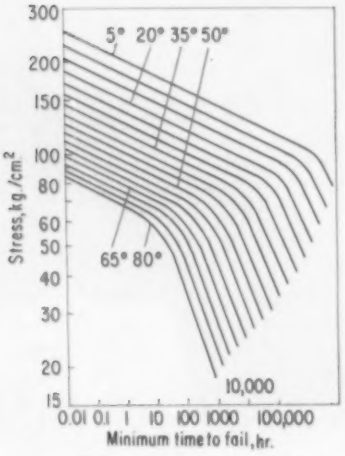

FIG. 1: Isotherm (°C) data for pipe fabricated from high density polyethylene (Hostalen GM 5010). Source: K. Richard.

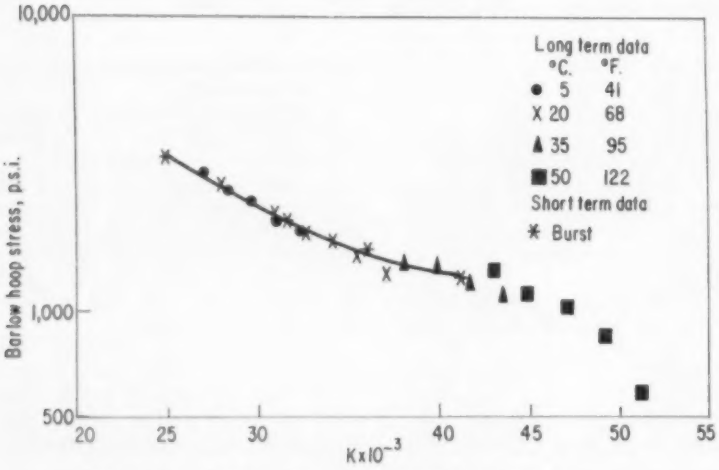

FIG. 2: New master rupture curve for high-density polyethylene. $T_o = 800°$ F. absolute.

Skimmed the surface

Sir: We wish to congratulate Irving Abramowitz for his article, "Let's not price ourselves into the red," in your June 1961 issue.

We believe, however, that this article skimmed the surface on one of the deficiencies of the plastics processing industry, and that it did not arrive at the heart of the problem. Our problem can be stated in three simple conclusions.

First, sales must be quoted in terms of units. Units should be a descriptive term selected to tabulate most clearly the product being sold. Hence, pipe units are most ideally linear feet; sheeting units, square feet; average molded items, per unit; etc.

Second, sales prices should be calculated to include raw material costs, processing or manufacturing costs, general and administrative costs, marketing costs, plus a legitimate margin of profit.

Third, a legitimate profit margin should be commensurate with risk taken, should permit a continued growth capability from retained earnings, and should return a fair margin for goods or services rendered. It is not necessarily the absolute maximum that the market will bear. Frequently, it is a margin that enhances the broadening of a market for competitive reasons, and that tends to reduce the manufacturing costs per unit through increased productivity.

There has been entirely too much pricing per pound and pricing per processing hour, and too little pricing based on true costs plus profit. Let us recognize that we will experience continued, if not increasing, competition, and strive to reflect more truly the costs of these items which we sell. This will help us to sustain our growth to meet increasing operations.

W. H. Roper
VP and Gen. Mgr.
Delkay Plastics Corp.
Gardena, Calif.

Self-extinguishing property

Sir: As an avid reader of MODERN PLASTICS, and one who realizes the great impact of your magazine, I hasten to point out an inaccuracy in the chart prepared by Mr. Griff and published on page 97 of the July 1961 issue.

I refer specifically to the "ABS Polymers" in the last column having to do with the "self-extinguishing" property. This is entirely incorrect. Since the first B-36 bomber took to the air, down to the present, Royalite plastic products have advertised and sold, and the major builders of commercial and personal airplanes have used, many tons of Royalite in their ships. It is identified by the designation, Royalite 50, and meets FAA specifications as well as certain U.L. requirements.

At the present, the committee of the S.P.I., working with the Bureau of Standards, is setting up a specification for ABS sheet, with one category for the "self-extinguishing" grade.

W. C. Schlager
Manager of Sales Engineering
Royalite Plastic Products
U. S. Rubber Co.
Chicago, Ill.

Bothered by one thing

Sir: On page 249 of your May issue, you gave us a very nice editorial comment on our new polypropylene Solution Bottle. But we are bothered by one thing. The headline states that "Polypropylene competes with Pyrex." This is true in this case, but we have always tried to steer clear from making a direct comparison of our laboratory apparatus with that of Corning's Pyrex.

We do not feel that plastics are a replacement for glass apparatus but an adjunct. We like to imagine that laboratory glassware people feel the same way towards plastics. Our aim is to make good products which will help the laboratory workers.

Emanuel Goldberg, Pres.
The Nalge Co. Inc.
Rochester, N. Y.

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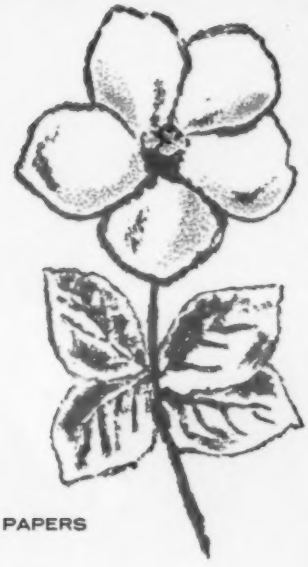

Original type and engravings are never used in long-run, high-speed flexographic printing. They wear out too soon. Instead, the printing is done by rubber duplicates.

The method of duplicating these plates is to make molds or "matrices" by squeezing thermosetting resin-impregnated paper against the originals under high pressure and heat, then casting the rubber in these "plastic" molds.

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TECHNICAL PAPERS FOR INDUSTRY

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At the heart of Lido's efficient manufacturing process are Fellows No. 12-350 Injection Molding Machines. In many cases these machines of intermediate size are faster than smaller machines for large area, thin wall parts. They dry-cycle at 600 to 800 per hour and make shots up to 20 ounces with the standard Pre-Pac device which double strokes the plunger during press dwell. The Fellows No. 12-350 is easy to set up and operate. Being fully automatic, it requires only part time supervision.

Using tough-to-mold, super-high-impact styrene as well as regular and linear polyethylene, Lido reports that their Fellows machines are both efficient and trouble-free, with no major breakdowns.

Find out for yourself how Fellows injection molding machines can help you lick even the toughest jobs. Your Fellows representative will be pleased to give you complete information.

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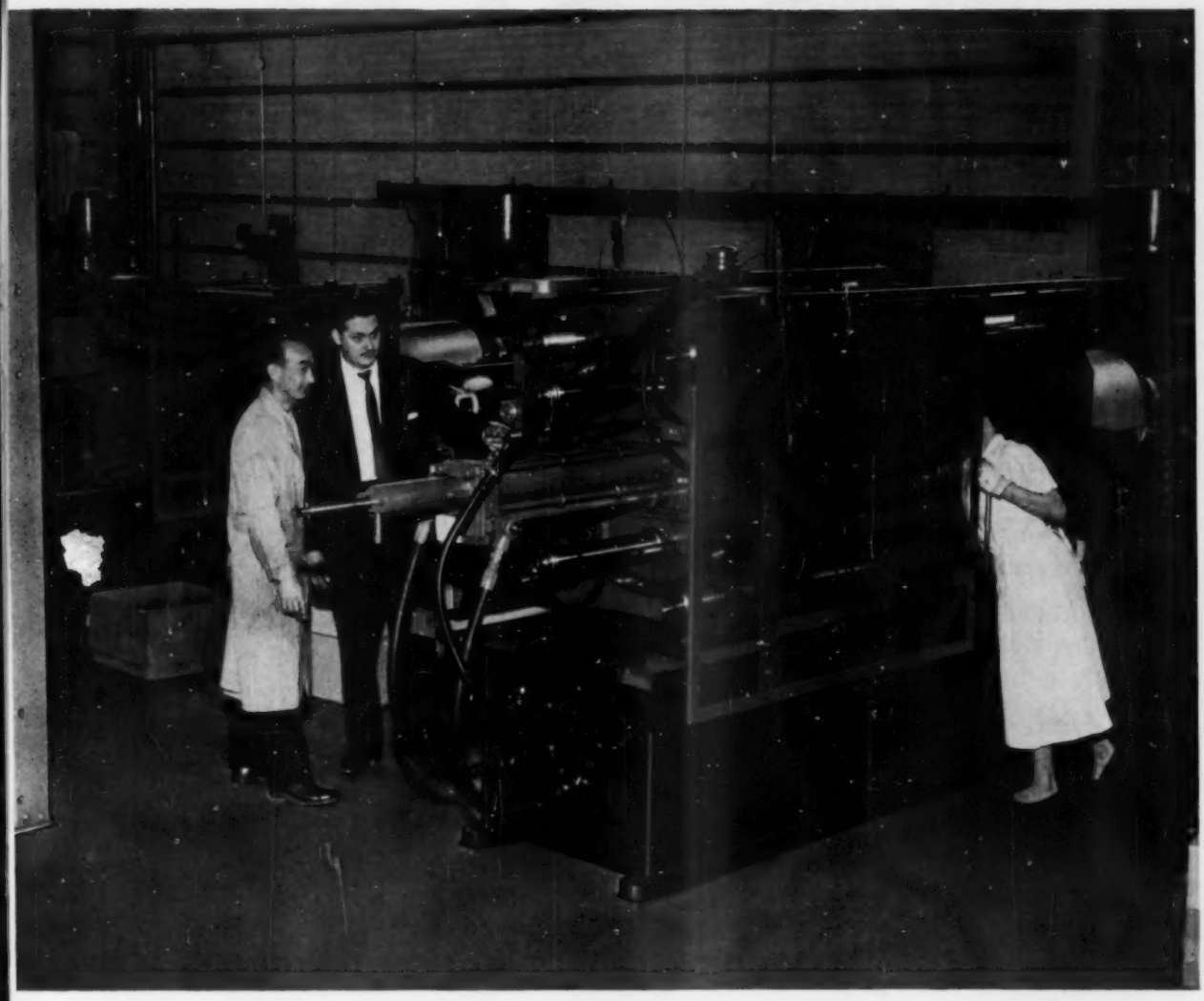
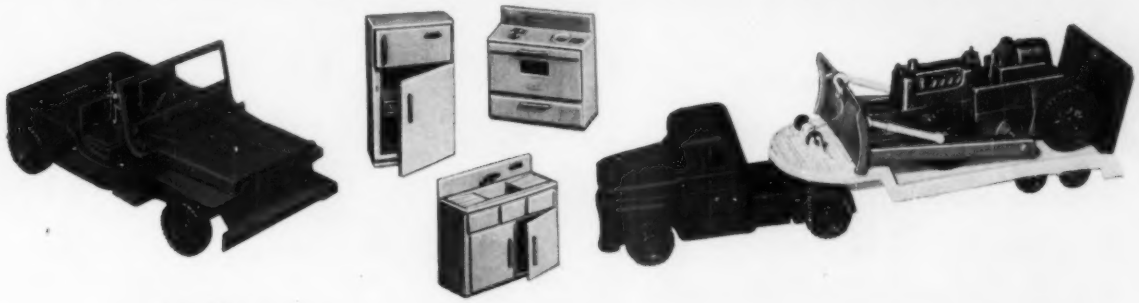


George Suzuki, Molding Supervisor-attendant and Mr. Moe S. Smith, President in Lido molding department



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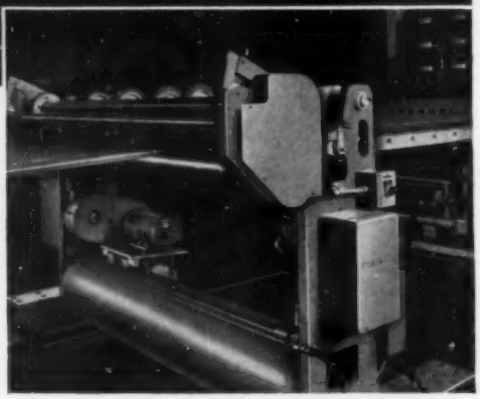
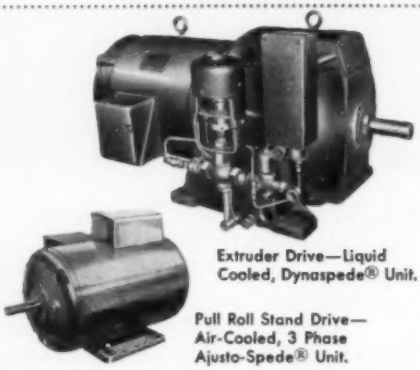


Unique, continuous extrusion of a corrugated translucent, vinyl sheet at National Rubber Machinery Company, Akron, Ohio. Pull Roll Stand (inset above) is powered by an Eaton fractional horsepower Ajusto-Spede® Drive.



Extruder Drive—Liquid Cooled, Dynaspede® Unit.

Pull Roll Stand Drive—Air-Cooled, 3 Phase Ajusto-Spede® Unit.

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HEYDEN

EPOXY RESIN CHEMICALS

HEYDEN CHEMICAL DIVISION
342 MADISON AVE., NEW YORK 17, N. Y.
HEYDEN NEWPORT CHEMICAL CORPORATION

PENTAMIDS

(liquid polyamides for epoxy resins)

STRUCTURE – Pentamid 1 and Pentamid 2 are polyamide resins produced by the condensation of polymerized fatty acid and suitable polyamino compounds. Pentamid 1 is a high viscosity (40 poises @ 75°C) polyamide resin with an amine value of 215; Pentamid 2 is a low viscosity (11 poises @ 75°C) resin with an amine value of 305

PROPERTIES – Cured Pentamid Polyamide Resin Epoxy systems offer the following advantages:

- Excellent resistance to mechanical impact
- Exceptional resistance to thermal shock
- Exceptional adhesion to various materials
- Excellent resistance to solvents, chemicals and water
- Low shrinkage on cure and exceptional dimensional stability
- Low exotherm for safety in casting operations
- High flexural, compressive and tensile strength
- Convenient handling without need for solvents
- Freedom from volatile, toxic or temperature sensitive curing or accelerating agents

APPLICATIONS –

Coatings – In coating applications, thermosetting resin alloys of Pentamid 1 or Pentamid 2 epoxy blends provide excellent protective and decorative coatings where resistance to chemicals, solvents, heat and water is important. Both clear and pigmented coatings can be made having exceptional gloss, flexibility, hardness, abrasion and impact resistance.

Structural Adhesives – Extremely tough structural or load bearing adhesives capable of bonding a wide variety of surfaces are readily obtainable from the reaction of Pentamid 1 or Pentamid 2 with epoxy resins. The cured adhesives have high tensile shear strength and excellent resistance to impact or mechanical shock.

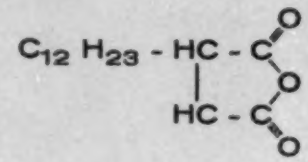
Casting and Laminating – Excellent for such applications is the cross-linked or three dimensional polymer which results when Pentamid 1 or Pentamid 2 are combined with epoxy resins. Properties of the thermoset products resulting from the Pentamid cured epoxy include: exceptional wetting characteristics, low shrinkage, high structural strength, chemical resistance, corrosion resistance and exceptional toughness.

DDSA

Dodecenyl Succinic Anhydride

(liquid anhydride curing agent for epoxy resins)

STRUCTURE –



PROPERTIES – Cured DDSA-Epoxy systems offer the following advantages:

- DDSA imparts toughness, flexibility and attractive electrical properties to cured resins
- Readily miscible with liquid epoxy resins at room temperature and compatible with solid epoxy resins
- Imparts long pot life to resin mixtures
- DDSA-cured resins show very low weight loss at elevated temperatures
- Imparts low viscosity to room temperature mixtures
- Volatility is low, minimizing losses and objectionable fuming during cure
- Promotes safety in castings with low exotherm

APPLICATIONS – Because of its ease of handling, long shelf life and the favorable physical properties obtained in cured epoxy systems, DDSA is ideal for a wide variety of laminating, casting, electrical and adhesive applications.

Product Availability

One pint samples are supplied on request. Commercial quantities are available for immediate shipment.

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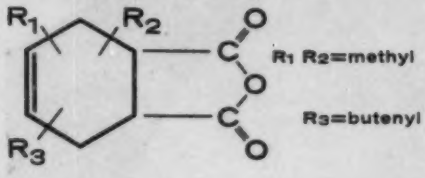
BETA-S®

Dimethyl Butenyl Tetrahydro Phthalic Anhydride

(liquid anhydride curing agent for epoxy resins)

STRUCTURE –



PROPERTIES – Cured Beta-S-Epoxy systems offer the following advantages:

- Excellent electrical properties with high HDT* resistance
- Long pot life facilitating assembly line operation
- Low viscosity mixtures can be prepared for improved penetration and wettability
- Readily miscible with liquid epoxy resins at room temperature, and compatible with solid epoxy resins
- Low exotherm, facilitating safe use in casting operations
- Volatility is low, minimizing losses and objectionable fuming during cure

APPLICATIONS – Beta-S is a highly effective curing agent for epoxy resins and is primarily consumed in electrical, tooling, and laminate applications. It is miscible with liquid epoxy resins at room temperature, yielding free-flowing potting and casting compositions of good pot life. On heating, these systems cure to resins of high heat distortion temperature and excellent electrical properties.

*Heat Distortion Temperature

TERPOX®

(viscosity modifier for use with epoxy resins)

STRUCTURE – Difunctional oxy derivative of a terpene

PROPERTIES – Cured Terpox-Epoxy systems offer the following advantages:

- Low working viscosities can be formulated with minimum sacrifice of heat distortion temperature
- Reactive character of Terpox leads to resins of good physical characteristics
- Readily miscible with epoxy resins at room temperature
- Imparts better wettability and penetration to the resins
- Exhibit little loss of weight during heat curing cycles
- Terpox-Epoxy mixtures show good room temperature storage stability
- Terpox is difunctional permitting polymer buildup to desired molecular weight
- Terpox is a light colored liquid of pleasant odor

APPLICATIONS – An extremely effective viscosity modifier in liquid anhydride cured epoxy resins, Terpox provides very low working viscosities, yet due to the reactive character of Terpox, the systems in which it is incorporated are curable to resins of good physical characteristics. The advantages of better penetration and increased filler loading are readily available from incorporating Terpox in potting, casting, laminating, coating, adhesive formulation, body solders and concrete patching compounds.

PRODUCTS ARE AVAILABLE IN THE FOLLOWING CONTAINER SIZES

	Pentamid 1 lbs./pkg.	Pentamid 2 lbs./pkg.	Beta-S lbs./pkg.	DDSA lbs./pkg.	Terpox lbs./pkg.
55 Gallon drum	400	400	470	450	425
5 Gallon drum	40	40	45	40	40
1 Gallon drum	8	8	9	8	8

HEYDEN CHEMICAL DIVISION
342 Madison Ave., N.Y.C. 17, N.Y.

Gentlemen: Please send the following:

DATA: ☐ PENTAMIDS ☐ DDSA ☐ BETA-S ☐ TERPOX
SAMPLE: ☐ PENTAMIDS ☐ DDSA ☐ BETA-S ☐ TERPOX

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

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beta-Oxynaphthoic Acid
Chlorotoluenes
Creosotes, Medicinal
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Formic Acid
Fumaric Acid
Guaiacols
Hexamethylenetetramine
Hydrochloric Acid
LIGNOCOL® (Anti-Skinning Agent)
Maleic Anhydride
Methanol
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Paraformaldehyde
PARASEPTS® (Antimicrobial Agents)
Pentaerythritols
PENTEK®
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Sodium Benzoate
Sodium Formate

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TECHNICAL ASSISTANCE
We will be pleased to provide you with further information or technical assistance on the use of Heyden-Epoxy Resin Chemicals. For further information, contact your nearest Heyden Chemical Division Sales Office.

The information in this bulletin is believed to be accurate, but no warranty is made in this respect. In submitting this information, no liability is assumed or license implied with respect to any existing or pending patent.

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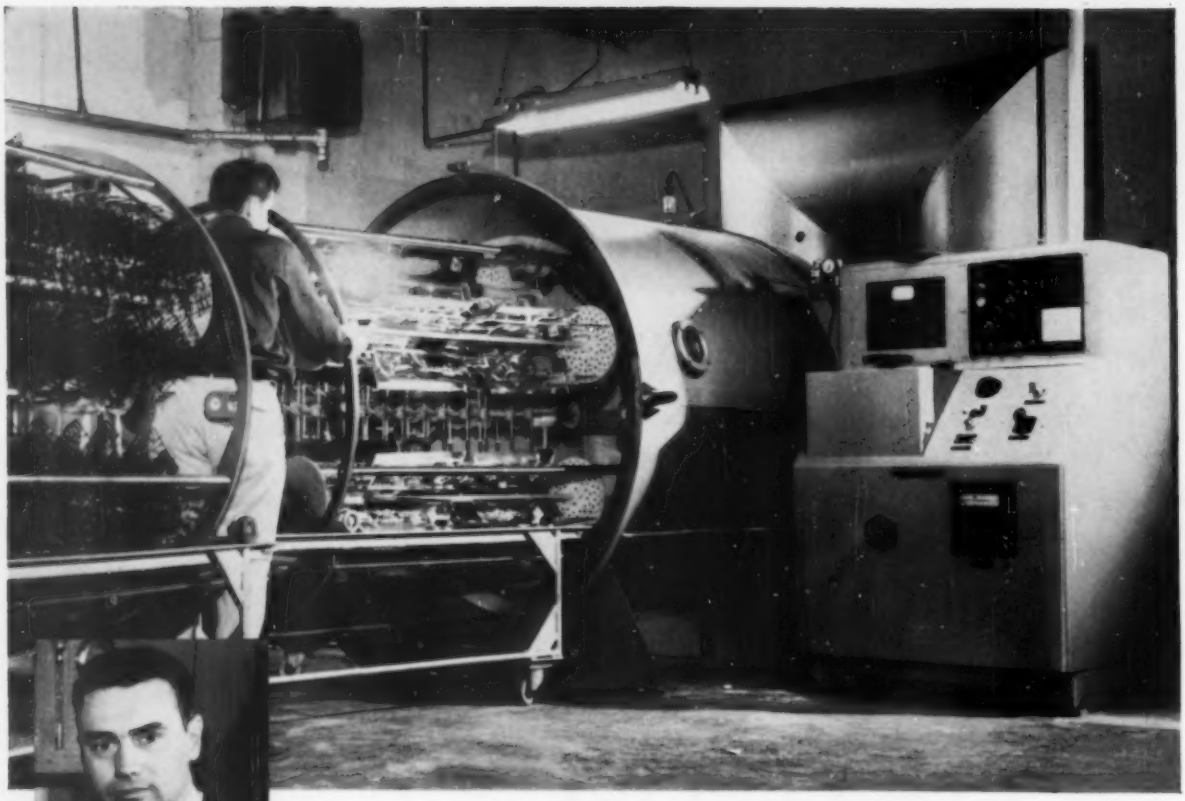


"NRC Vacuum Coater Cuts Production Time 75% Improves Schedules 100%"

. . . says James Kerr, Manager,
Electro-Vac Division of Radio Cores, Inc., Chicago, Illinois.

"Increased demand for our plating work required newer, more productive equipment. We investigated the vacuum coating equipment of several manufacturers and chose the NRC Equipment Corp. Model 3156.

"As for solving the problem of increased demand, the new NRC Vacuum Coater has more than quadrupled our output. Floor space is the same as the old equipment.

"Our plating cycle has been reduced 75 per cent. Humid weather no longer slows our production. The more efficient pumps and mechanically refrigerated cold trap on the NRC equipment have overcome the humidity problem.

"Delivery schedules have improved about 100 per cent. There are no production variations because of the NRC's dependability. Results are consistent.

"NRC installed the new coater and handled personnel training . . . only one week was needed to break in our own operator."

Electro-Vac has become a big contender in the growing finishing field . . . the company produces a quality product on modern equipment faster and at lower production costs. Interested in cutting your operating costs?

Send for the new Vacuum Coater brochure today.

NRC
EQUIPMENT CORPORATION

A Subsidiary of National Research Corporation
160 Charlemont Street, Dept. 19-I
Newton 61, Massachusetts

U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

SEPTEMBER, 1961 — U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corporation — 99 Park Ave., N. Y. 16, N. Y.

Packaging Notes

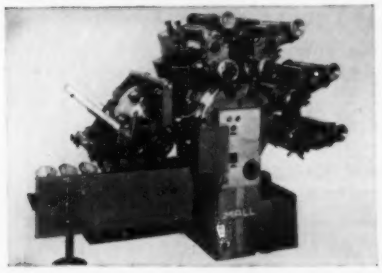
Reusable closure for polyethylene bags is airtight — protects against humidity, leakage, odors, mildew, hardening, de-

composition. Easily attached, it comes in three sizes and a range of colors; is especially suitable for rack display and tie-in merchandising. This clip, originated in France, has been widely used in Europe for packaging foods, chemicals, drugs, precision instruments, notions, sweaters. A Yonkers, N. Y., company is the American manufacturer and distributor.

Adjustable-flow bottle for hydrofluoric acid is molded entirely of polyethylene. Unique closure (design patented) permits user to actually "dial" the rate of flow—from a single drop to a steady stream. There's no diaphragm to puncture: the one-pound container has a slip-on dust cover which protects against contamination and leakage.

New primer, said to be an excellent adhesion promoter, does away with the need to age film surfaces prior to extrusion coating with polyethylene. Can be used on cellophane, polyester, aluminum, many other films and foils. Application is by wash coat. Coverage: 10 lbs. per 3,000 sq. ft. wet.

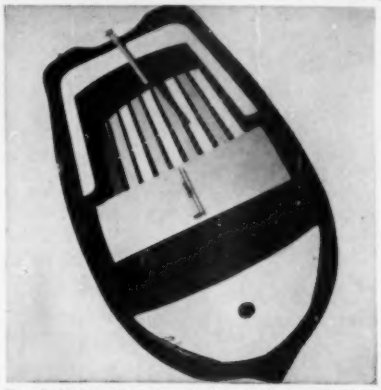
Offset printing machine decorates round and tapered polyethylene containers and bottles in four colors at a production speed of 80 pieces per minute, maximum. It handles bottles up to 13 inches high, four-inch diameter full circumference and six-inch diameter ⅔ of circumference.



First Commercial Products Of U. S. I.'s Powdered Polyethylene Introduced

Outsize Items Molded from MICROTHENE® by New Technology

One ton-capacity meat tanks, nine-foot long boats and 13-gallon containers are among the first products made of powdered polyethylene to be marketed in the U.S. All three are being produced by powder molding. This is a new polyethylene technology used in Europe, but relatively unknown in America until U.S.I.'s MICROTHENE became available nearly two years ago.



Tough, lightweight boat hull is made from U.S.I.'s MICROTHENE finely-divided polyethylene. It will retail at a price lower than comparable boats of reinforced plastics.

Process is fast, easy, economical

Larger than ordinary moldings can be made from powdered polyethylene. The process is fast and requires simple, relatively inexpensive molds. Ease and economy of production give many items made by this method a price advantage over those molded by conventional procedures.

The new boat, molded from black MICROTHENE by an Indiana company, is typical. It has the first full-sized hull made of conventional polyethylene, without the use of wood or metal inserts for stiffening. It will retail at a price lower than comparable boats. It won't rust or dent. Can be used with outboard motors up to 5 hp.

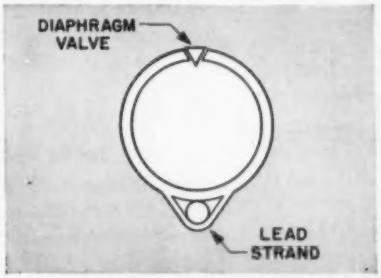
The same company utilizes MICROTHENE to produce a meat tank for use in packing and processing plants. It is thick-walled, easily cleaned and resistant to juices and chemicals; holds one ton of liquid or bulk product.

The 13-gallon MICROTHENE "bottle", produced in Brooklyn, N. Y., is lighter and takes less storage space than the glass carboys it's designed to replace. It is also unbreakable and corrosion resistant — characteristics which virtually assure its success in the chemical industry. The manufacturer has received ICC certification for the 13-gallon container. The company can reportedly produce up to 800 of the units in a normal 40-hour production week.

Extra-large meat tank made of MICROTHENE—designed for transporting, storing or process-handling meats—is one of the first results of the new polyethylene technology called powder molding.

Ice Melting System Uses Polyethylene Tubing

Weighted polyethylene tubing is an integral part of an automatic aerating and ice melting system currently being marketed. The equipment, inexpensive to install and operate, is designed to provide year-round open water for wildlife sanctuaries . . . prevent winter fish-kill . . . and eliminate ice damage to docks, piers, boats, locks, dams, etc.



As shown in the schematic drawing, the tubing has a built-in strand of lead along the bottom and diaphragm valves at given intervals along the top.

During service, needle-point amounts of oil-free air are forced into the water through the valves in the submerged hose. The air gently circulates the earth-warmed bottom water — which aids in ice melting. The air also furnishes oxygen for the fish, and for burning up organic debris.

U.S.I.

Series VI, No. 5

POLYETHYLENE PROCESSING TIPS

HONING AND REPLATING EXTRUDER DIE LANDS

Cleaning and polishing the die lands of polyethylene film extruders and extrusion coaters on a regular basis will minimize the amount of poor quality production resulting from contaminated die lands. Procedures for such maintenance were outlined in a previous *U.S.I. Polyethylene Processing Tips*—Series VI, No. 4.

Even with the best care, however, it still is necessary to refinish the die lands periodically either by honing or, if they are chrome plated, by replating. Lands need refinishing if they have rough spots (as shown by lines in the polyethylene film or coating) that cannot be eliminated by cleaning and polishing.

Honing Flat Film Die Lands

The procedure for honing flat film and extrusion coater die lands is as follows:

1. Fabricate a holder of soft material that will not mark the lands for the honing stone, similar to the one shown in Figure 1. Wood or Micarta plastic are two suitable materials for the holder.

2. Be sure the lands are cool before honing. Hot lands are easily marked.

3. Place the lands, or jaws if they are in one piece, in a table vise so that the lands are upright. See Figure 2.

4. Hone the lands, keeping the stones wet with kerosene during the entire honing operation.

- Start with a 400 grit stone in the holder. Hone the lands until all visible imperfections are removed.
- Follow with a 600 grit stone. Continue honing until a very smooth surface is obtained.
- If desirable, hone briefly with an 800 grit stone for a mirror finish.

Precautions During Honing

While the die lands are being honed, it is extremely important to hold them in an upright position in a rigid mounting block or vise, as shown. The stone must be positioned firmly in the holder so that the stone will be flat against the lands' surface at all times. Never try to hone only a small area of the lands—hone across their entire length with smooth, even strokes. As you hone, be sure to keep the stone free from small bits of metal. These will undo your work by scratching the die lands.

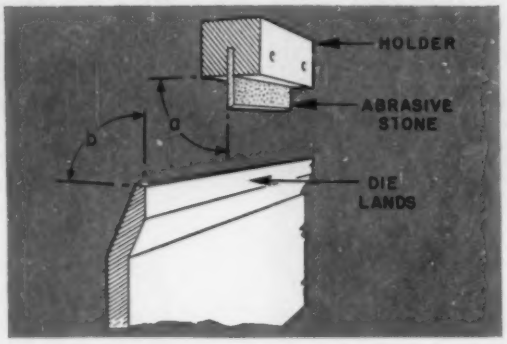


Figure 1—Honing stone and holder for honing flat film or extrusion coater die lands. Notice that angle between holder and stone (a) corresponds to angle between die land and face of die lip (b), 90° in this case.

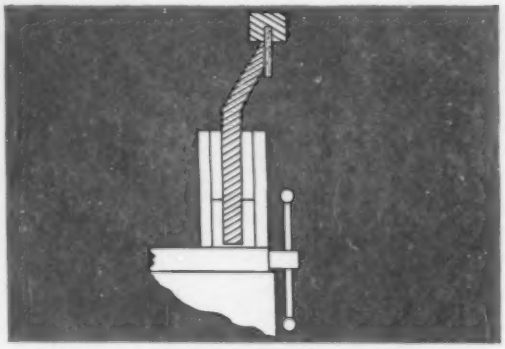


Figure 2—End view of die land honing operation.

Honing a set of die lands takes several hours. Therefore, it's a good idea to have a spare set available so that the extruder can operate while one set of die lands is being honed.

Only a precision machine shop should hone blown film dies. If your plant doesn't have one, send the dies out to an experienced shop for honing.

Special Treatment for Plated Dies

Chrome plated dies must be handled with extreme care. Honing will remove the chrome plate and is *not* recommended. If you can't smooth chrome plated dies by cleaning and polishing, send them out for replating by the die manufacturer or a shop experienced in such work.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
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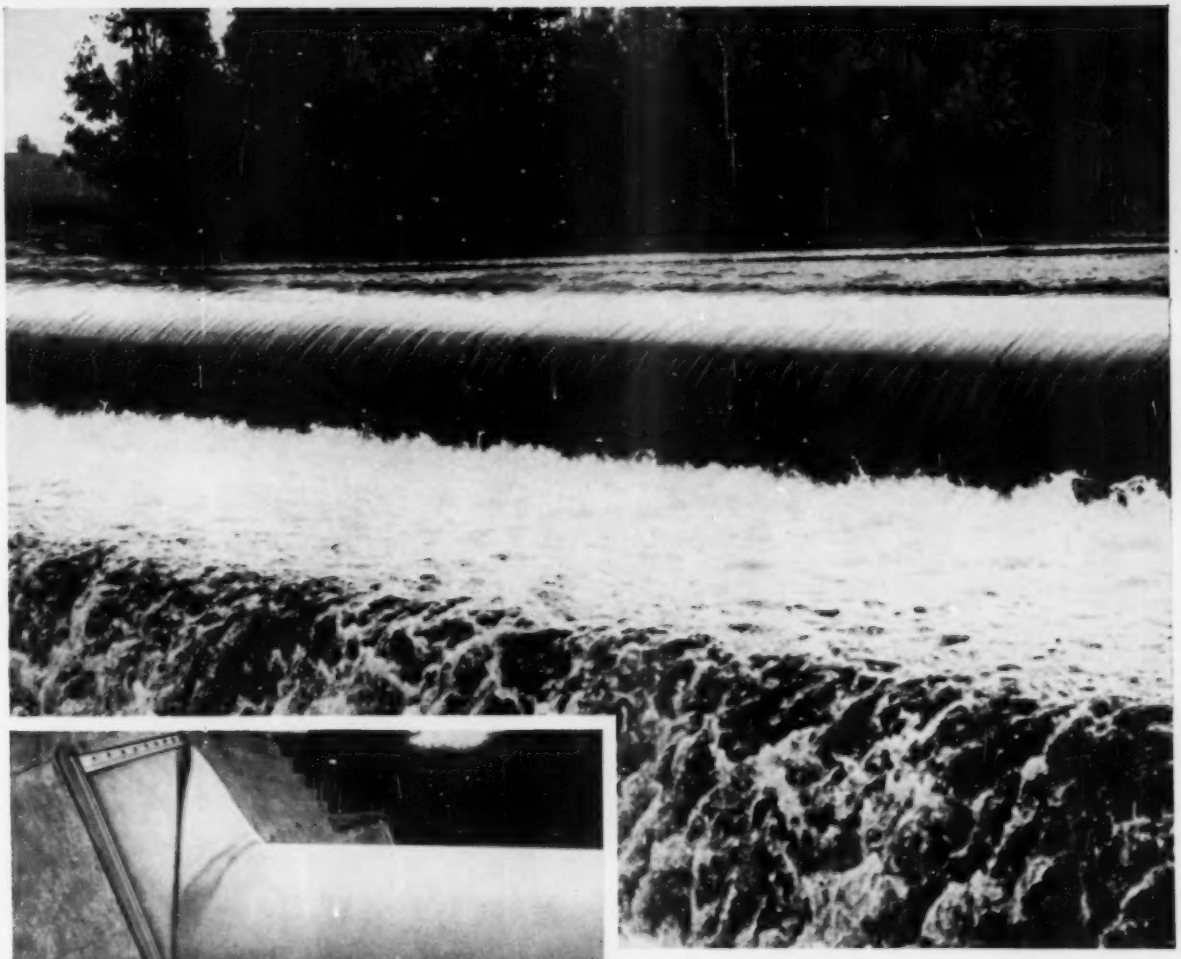
Revolutionary fabric dam inflates, deflates to control flow of water



Left: view of one end of inflated Waialua Fabridam before rains raised reservoir level. Easily installed on concrete foundation.

Above: water flows over Fabridam, from Wahiawa Reservoir into tunnel leading to plantation, at rate of 175 million gallons per day.

Irrigating the ten thousand acres of sugar cane under cultivation by the Waialua Agricultural Company, Ltd., of Waialua, Hawaii, takes more than 25 billion gallons of water a year. To conserve extra water available during wet periods, a remarkable new "Imbertson Fabridam by Firestone" was installed in the spillway of the Wahiawa Reservoir.

Far less costly than conventional control gates, this light, flexible fabric dam increases the storage capacity of the reservoir by 500 million gallons. During the rainy season, it automatically deflates sufficiently to prevent flooding.

Wellington Sears supplied the nylon base fabric used by the Coated Fabrics Division of The Firestone Tire & Rubber Company for the Fabridam. With a tough neoprene coating, it has outstanding resistance to deterioration from age and abrasion—for a life expectancy of 15 years.

This is but another demanding use which Wellington Sears fabrics serve. We have wide experience in engineering cotton and synthetic fabrics to specific jobs—and are always ready with sound technical assistance. For a copy of our illustrated booklet, "Fabrics Plus," write Dept. K-9.

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FIRST in Fabrics for Industry

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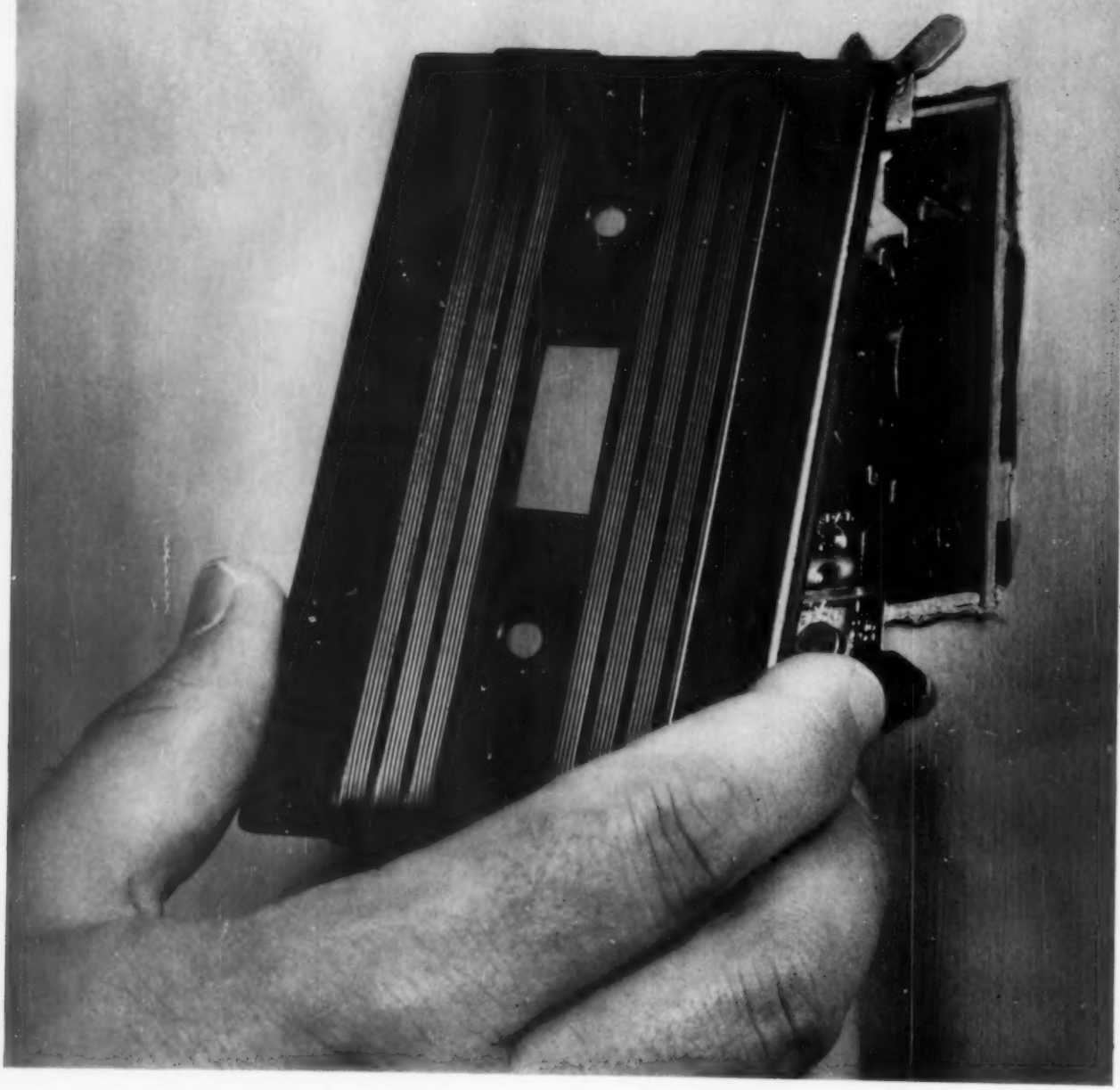
TODAY: THIS PART WAS MOLDED IN 30 SECONDS!



IN 1951: It took a minute and a quarter!
IN 1931: Over two minutes!

New BAKELITE BMM-7017 is one of the fastest-curing phenolics available. Nothing old about this workhorse—it dramatically highlights an overall 300% improvement in cure speed since 1931!

To stay new in phenolics takes research and development—in real depth. To give the manufacturer continuing improvements in moldability *and* product takes a complex team of men and equipment. You'll find them at UNION CARBIDE. For example, here are 4 new BAKELITE compounds you'll want to know more about:

BMM-7017, a general purpose two-step compound, is setting new production records in the field. Excellent mold and flash release. In cold powder automatic molding, 15% to 40% cycle reductions in fast-acting presses. Supplied in a new dust-free 16 mesh granulation.

BMG-2700 is becoming the new standard of the closure industry. A one-step compound, it is bleed-resistant, gives minimum odor. Offers not only very fast cure, but high torque strength, excellent moldability. Ideal for automatics.

BMG-2933, originally developed for vaporizers, gives excellent resistance to boiling water and low-pressure steam. High impact strength and fast cure as well. A one-step compound, it imparts no odor or taste to boiling water, keeps its good appearance after steam sterilizing.

BMGA-4127 and **BMGC-4011** still in the development stage, promise completely new thresholds of heat- and arc-resistance for phenolics. Laboratory tests reveal 4 times longer strength retention at 500°F. Can be used at temperatures 75° higher. ASTM arc-resistance values: 195 seconds average . . . 180 seconds minimum.

Want more information about new developments in BAKELITE phenolics? Just write Union Carbide Plastics Company, Dept. JZ-87J, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 12.

UNION CARBIDE **PLASTICS**

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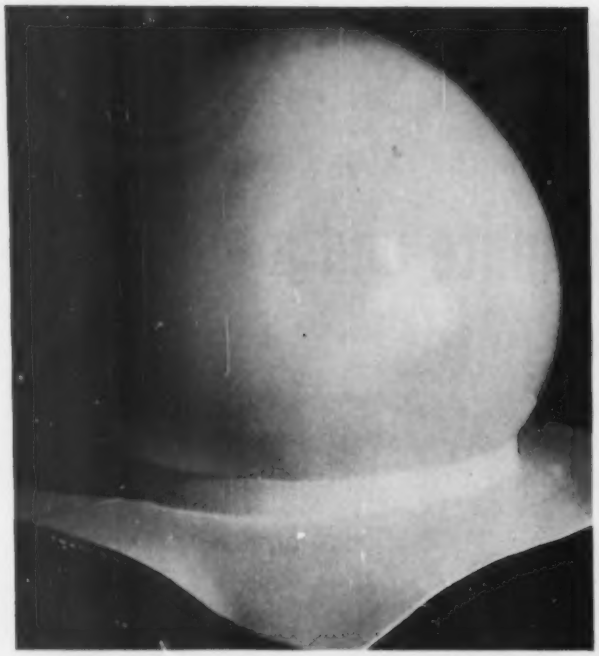
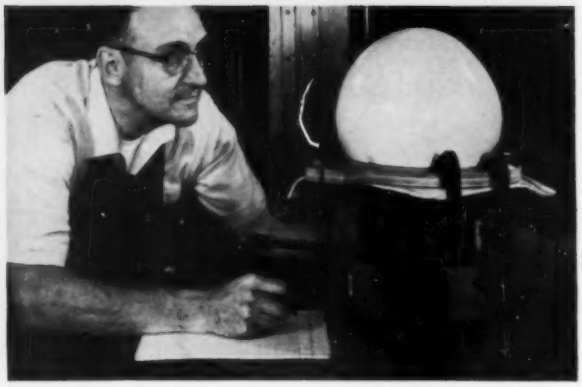


PVC sheets (12"x12"x⅛") were heated for 4 min. at 350°F., then subjected to gradually-raised air pressure. *Upper left:* Sheet containing 10% ACRYLOID® K-120N flowed easily to form smooth sphere. *Upper right:* Unmodified PVC (high pressures cause sample to tear). *Lower right:* Fixture used for applying air pressure.



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MODERN PLASTICS

September 1961 **Volume 39, Number 1**

Twenty-five years of technical leadership

In 1936, when Dr. Gordon M. Kline became Editor of the Technical Section of MODERN PLASTICS magazine, total United States production of plastics was 125 million lb., mostly phenolics, ureas, and cellulosics. World production was about 200 million pounds.

There was little technical literature in English; almost none in any other language except German. What literature there was, was in patents and intra-mural communications in chemical company laboratories. There were no multi-paper technical conferences, no erudite plastics national societies. The polymer sciences were but gleams in the eyes of their fathers.

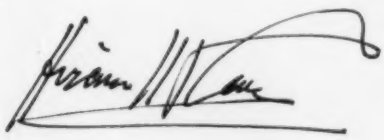
A depression, a world war, a scientific revolution, and a space age later, Dr. Kline looks back on the publishing of over 620 pieces of permanent technical literature on plastics chemistry, plastics processing, plastics testing, and evaluation.

The list of first technical discussions of new plastics materials and new processing methods over this quarter-century of publication of the Technical Section is prodigious indeed. The milestones of our progress stand therein, attesting to this man's leadership.

The Editorship of the Technical Section of MODERN PLASTICS has been and is but a minor part of Dr. Kline's activities on behalf of this industry, world-wide. He has written many technical books and has lectured in many parts of the world. He was a founder and chairman of Technical Committee 61 on Plastics of the International Standards Organization. He has been largely responsible for leadership in the voluntary standards program in plastics in the United States. His biography in *Who's Who* and in *American Men of Science* proves that he has been the recipient of many honors, all well-deserved.

We are sure that many of our readers will join with us in saying: For twenty-five years of scientific integrity, for twenty-five years of technical leadership, for twenty-five years of editorial acumen, we thank you, Dr. Gordon M. Kline!

And may your next quarter century of service be as fruitful.



Photo, Peterson Products

BOATS, which have proved a natural market for reinforced plastics, have demonstrated equally the advantages of manufacture through the spray-up process. Economics of both spray-up and hand lay-up are outlined in table, p. 92.

Photo, Plastic Engineering & Chemical Co.

VERSATILITY of spray-up method is shown by this use on a billboard in Florida. Hand, glass, and letters of tradename are all made by spray-up.

Some 750 guns are now spraying 10 million lb. of laminate a year in the U. S. This close look at the field shows how this technique is being applied and how it may increase in use many-fold in the next few years

SPRAY-UP

In the past several years a new method of making and molding reinforced plastics has fired imaginations in the field and opened up new markets with new economies. Spray-up is the generic name given to the process by its many promoters.

Basically, it consists of the simultaneous depositing on a mold of a catalyzed and promoted resin (usually polyester or epoxy) and chopped or continuous-strand fiber roving (usually fibrous glass). The work is done with depositor guns—which some equipment suppliers strongly point out should not be confused with the simple guns used for paint, gel-coat, or resin alone. Other makers, however, claim that a depositor is nothing more than a resin gun to which a glass fiber breaker or chopper has been linked in tandem. Some of the spray-up guns will also deposit filler or aggregate.

Spray-up competes in RP molding with hand lay-up of mat or woven roving, particularly in large pieces, complicated pieces, and short runs. Since no tailoring of mat is required, waste of fibrous glass is reduced and tailoring labor eliminated. Rapid delivery of composite material to molds by mechanical handling cuts labor costs, while fast cure (usually at room temperature but occasionally in ovens) makes for more rapid turnover of molds. Finally, fibrous glass is used in its lowest-cost form.

The chart on page 92 compares costs of making a 15-ft. hull using both spray-up and lay-up: $83.19 vs. $109.38.

Boats are a natural for spray-up, provided the operators know their skills. Generally, 60-strand roving with red, blue, or green tracer fibers are used and the proportion of mix is usually 28 to 32% glass, the rest resin. Once the gun is set, a steady hand is all that is required. Some boat companies have fully-automated plant-wide systems, with resins and catalysts delivered through ceiling pipes, and depositor guns with their service booms in fixed position, the molds traveling endlessly. This requires trained teams of mold cleaners and release appliers, compacters who roll out any air trapped in the deposited material, flash removers, and finish men. Automated, this is a high-speed process using 3 to 10 lb. of material per minute per gun and requiring many molds.

At the other end of the industrial scale are men with one gun for all work and a variety of single molds making short runs. And some of these put their guns and pumps and pots and glass choppers on trucks, traveling around to do all kinds of maintenance work.

There is room in the field for all sizes of enterprise, provided the users of spray-up know the techniques, the chemistry, the engineering, and the

LARGE MOLDINGS of intricate design are made practical by the simplicity and economics of the spray-up technique. This one-piece unit, combining bathroom fixtures and floor, is being produced in Western Germany.

Photo, Aust & Schüttler

Photo, Aust & Schüttler

SURFACING OF RESIN-GLASS LAMINATE is sprayed on concrete roof of tunnel system connecting buildings of hospital in Geneva, Switzerland. Such construction applications, applied as part of original design or later as repair work, may help boom spray-up market.

business. But to date the experts are few, the amateurs many.

Molding uses to which spray-up has already been put include boats, truck trailer parts, recreation equipment, watering troughs, pig pens, coffins, hen houses, swimming pools, shower stalls, missile parts, vending machine parts, air conditioning components. One large farm implement maker uses spray-up to make prototypes and test components. Those that are satisfactory are then transferred to matched-metal press molding from preforms to get mass production.

Beyond molding of reinforced plastics by spray-up comes the whole new field of structural maintenance—at once a department for a big company and an opportunity for a small one.

Spray-up repairs to leaky concrete or concrete block swimming pools; oil, water, and chemical tanks; wooden and metal freight cars; truck trailers; textile, dairy, and paper plants are all probabilities. In the case of the big industry, a new portable spray-up department is added to the maintenance function, especially where corrosive fumes or liquids cause trouble. In the case of the small operator, his truck and trailer take him and his equipment and supplies to the jobs.

At the present time, there are in use in the United States approximately 750 spray-up depositors engaged in either molding or the aforementioned maintenance work. Around the world in Britain, on the Continent, in Japan, India, Australia, Mexico, and Canada there are probably another 500 units. Some companies may have 30 or 40 guns in a single automated plant. But probably half of the guns sold to date have been to single-gun operators.

In the United States, these guns in 1961, when in use, will mold or apply about 3 million lb. of fibrous-glass roving, about 7 million lb. of resins. Development of a 10-million-lb. market per annum in such a short time is a phenomenon. But if all present spray-up guns were used more continuously and more efficiently, even if no more guns were sold, this market could be 10 times as big.

Figure 750 guns working 60 min./hr./8-hr. day. That's 360,000 min. total. Let's hit a medium glass-plus-resin rate of deposition per gun of 5 lb. per minute. That's 1,800,000 lb./8-hr. day. Divide that into 10 million lb./year and it comes out to less than 6 days' use per gun per year.

As one spray-up engineer puts it, "This process is so efficient that if accessory processes, equipment, and labor are not as efficient it has to stand still while other elements catch up!" There must be much inefficiency at present.

The efficiency of spray-up depends quite as much on the type of equipment, the kind and amount of resins, catalysts, and promoters used, and the kind of glass as it does on labor.

Take equipment, for example. A spray-up gun

can be made with a single-nozzle, double-spray system or a double-nozzle system, combined with a glass roving breaker or chopper. Choppers in the case of the single-nozzle guns are generally placed on top, feeding down through the resin-catalyst spray. In a double-nozzle gun, the chopper may be placed between the nozzles, so that a stream from one nozzle containing catalyst plus resin meets the chopped glass at the same time it meets the other stream of resin plus promoter. All three then deliver to the mold. If there is no venturi or blower on the glass chopper, the centrifugal force of the chopper rollers combined with the force of the resin stream carries the glass to the mold and there is a possibility of too much unidirectional delivery, which is overcome by spraying in all directions. The reason for the colored tracer fibers in spray-up roving is to give a visual indication of how uniform is the thickness of the glass fiber layers.

Some companies make complete spray-up guns, some make resin spray equipment, some make glass breakers, some make both resin spray guns and glass breakers, but sell them separately. Pumps, tanks, and hoses are generally available. So some hardy souls buy the parts—the pumps, the nozzles, the triggers, and the choppers—and assemble their own spray-up guns with handlebars from second-hand bicycles and other gadgetry! This way lies nuisance for the spray-up gun makers and the glass and resin people—and headaches for the do-it-yourself people.

In glass roving the problem is not as great. Most of the glass people are making special roving for spray-up. In general, "E" glass is preferred to "A" glass, because it is less likely to split or "brush" during cutting. For the U. S. market, only "E" glass is used for spray-up. There is still much argument concerning sizings. Johns-Manville recently introduced a new gun roving declared to be static-free. It has a chrome-type binder. Choice of roving and binder depends on the gun, the chopper, the system, and the job.

When we come to resins and catalysts and promoters, the confusion is somewhat fantastic. In England (1)[1] it has been found that MEKP (methyl ethyl ketone peroxide) and CAP (cyclohexamone peroxide) with cobalt naphthenate promoter or accelerator will give good results, but the mixture of resin and catalyst will gel in a short time and equipment must be cleaned out frequently. So they turned to BPO (benzoyl peroxide) catalyst and DMA (dimethyl aniline) accelerator. The resin-catalyst mixture has a pot life which will vary from 8 hr. to less than a week, dependent on ambient temperature. There is reported, however, a tendency for the latter combination to yellow on weathering, and gel coat must be used where products are unpigmented

[1]Numbers in parentheses designate references at end of article, p. 203.

Photo, Spray-Bilt Inc.

MOBILE SPRAY-UP UNIT is used to repair and resurface columns and facade of Florida church. Such units, some trailer-mounted, are being used by growing number of small fix-it and maintenance companies.

VAN INTERIOR is given new, protective coating atop its plywood surface. Here spray-up apparatus was extended by boom from back to front of large trailer. Spray-up renovation of van took only 5½ hours. Photo, Plastic Engineering & Chemical Co.

and unfilled. In Germany DMA worked well, too, but sometimes discolored the laminates. The new gel-coats with MEKP have ultra-violet absorbers in them.

The Chemicals and Plastics Div. of FMC Corp. recommends using diallyl phthalate (DAP) monomer as an extender for MEK peroxide in catalyst injection spray-up systems. The non-volatile monomer is said to reduce fire and health hazards as opposed to commonly used solvents and cross-links with the resin, eliminating the possibility of solvent entrapment. In addition, the solution has excellent storage stability, says FMC.

Big problem in acceleration and catalyzation is the vagaries of weather, particularly in out-of-doors cure and room-temperature cure, and especially in climates of widely-varying temperatures. Adjustment of catalyst-promoter ratios is learned by trial-and-error, as is the ability to foretell temperature two days ahead (2).

As to resins, there are now many standard spray-up polyesters, both isophthalic and orthophthalic, on the market. They must not be too thin nor too thixotropic (non-dripping) (3). Any resin must be selected in combination with the catalysts, the promoters, the system, and the job to be done. Fortunately, the chemical companies are building a good body of experience-based literature.

A growing problem in spray-up, as more and more people adopt it, is health and safety of the operators. Gloves and barrier creams should always be used; face masks are required in many instances. Chrom-O-Lite Co., Minneapolis, Minn., builder of plant spray-up systems, is introducing a new ventilation system to remove dust and volatiles on a plant-wide basis.

About the only way to cover the machinery story is to list the principals and their offerings.

Aust and Schüttler u. Co., Düsseldorf, West Germany, makes the MAS spray-up machines, represented in the United States by Polymer Machinery Corp., Santa Ana, Calif., and Bound Brook, N. J. They have two main types of machines: the big ones in which the roving cutters are installed separately and the chopped glass is fed to the guns by pressure hose, and the small type in which the chopper is built into the gun itself. The use of air pressure to feed glass is said to permit more efficient spraying of vertical and overhead surfaces.

I. G. Brenner Co., Newark, Ohio, makes a variety of glass cutters for spray-up use, but is not in the gun business.

Chrom-O-Lite Co. sells systems of any size. While its main interest is in furnishing equipment up to the actual gun head, it also sells the Peterson gun. Plants using its patented folding boom and double-wall hose have continuous circulation of resins, cutting down on clean-up.

Associated with this company is Idea Inc. (Industrial Development and Equipment Agency), established for the purpose of leasing or renting equipment to industry.

J. Coudenhove Kunststoffe Maschinen, Vienna, Austria, makes a Polyspray gun using a two-pot system and an air motor on the chopper.

Fiberlay Inc., Seattle, Wash., features a system that does not chop the rovings, **(To page 201)**

Cost comparisons for making 15-ft. hull by spray-up and by hand lay-up[a]

BY SPRAY-UP			
Materials	**Quantity/lb.**	**Price/lb.**	**Cost**
Glass roving (33 1/3%)	60.3	$ 0.44	$26.53
Resin (66 2/3%)	124	0.31	38.44
Gel coat (15 to 20 mils)	12	0.57	6.84
Catalyst, BPO	1.24	1.05	1.30
Catalyst, 5946	0.374	0.50	0.19
MATERIAL COST (197.914 lb.)			$73.30
WASTE (5%)			3.89
TOTAL MATERIAL COST			$77.19
Labor, 3 hr. ($2 pr. hr.)			6.00
TOTAL COST OF HULL			$83.19

BY HAND LAY-UP			
Materials	**Quantity/lb.**	**Price/lb.**	**Cost**
MAT			
1 oz.	11.25	$ 0.62	$ 7.03
1½ oz.	17	0.62	10.54
Woven roving	32	0.70	$22.40
Resin (66 2/3%)	124	0.31	38.44
Gel coat (pigmented, 15 to 20 mils)	12	0.57	6.84
Catalyst	1.03	1.90	1.95
MATERIAL COST (197.43 lb.)			$87.20
WASTE (10%)			9.18
TOTAL MATERIAL COST			$96.38
Labor, 6½ hr. ($2 per hr.)			13.00
TOTAL COST OF HULL			$109.38

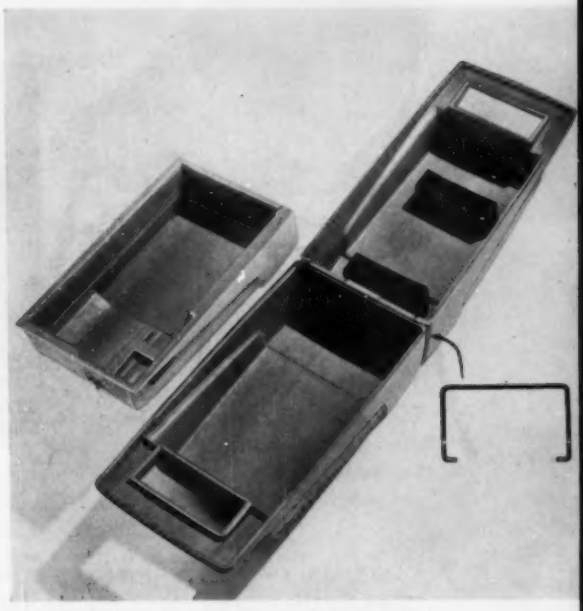
[a]Figures courtesy of a spray gun manufacturer. Data compiled by independent laboratory.

Injection molding, vacuum forming, and foam molding create . . .

A TOUGH CASE !

Photos, Pitney-Bowes

CARRYING CASE features virtually all-plastics construction to protect new postage meter from damaging impact shock. Pebbled texture is result of hand tooling of mold cavities. Identification is two-color heat stamping.



SHELL HALVES of case are injection molded of ABS. Cushioning insert (top) is vacuum-formed ABS sheet onto which expandable styrene has been molded. Wire bail sketched at right is one of pair used to hinge shells.

For its latest model postage meter (#5300), Pitney-Bowes Inc., Stamford, Conn., has combined vacuum-formed ABS (acrylonitrile-butadiene-styrene) sheet with foamed-on polystyrene into a snug, one-piece inner cushion for delicate meter parts. At the same time, it has turned to injection molding of ABS for the economical fabrication of the scratch-resistant, impact-resistant outer shell of the case. Out of this combination of materials and processes has been created what may well be a forerunner of future carrying equipment for other portable office machines.

The company, which leases the postage meters to commercial establishments and is responsible for their general upkeep, developed the cushioned carrying case for three purposes: as a shipping case; as protection for the meter when the user carries it to the post office for setting of the registers; and as a storage container.

Foamed insert with formed surface

The unique PS foam-ABS sheet cushioning insert is produced in the following manner. First, the 30-mil flexible sheet is vacuum formed to match the contour of the male half of the foam mold. Stretching during forming brings sheet thickness down to 6 mils at some points. When formed, the sheet is positioned over the male half of the mold. When the mold is closed, a cavity remains between the upper surface of the sheet and the female section of the mold. Polystyrene beads are blown into this cavity between sheet and mold, steam is introduced through vents in the mold, and the beads are expanded to a final density of 4 lb./cu. foot.

The completed insert thus has a top surface of scuff-resistant ABS sheet and a cushioning layer of foam. This insert is bonded into the half of the shell that nests the underside of the meter. Cushioning of the top of the meter is effected by two blocks of foam rubber which are cemented into the other half of the shell.

Originally, vacuum forming was considered for the two-piece shell, but, although formed carrying cases are still used for certain of the older postage meter models, a cost analysis showed that injection molding of the shells would be more economical for the quantity **(To page 207)**

First one-piece molded

Photo, Spencer Chemical

Photos, AviSun Corp.

VANGUARD OF POLYPROPYLENE'S PENETRATION of the seating market: side chair (above) and arm chair (right). Respective shot weights are 3 lb. and 3 lb., 11 oz.; respective prices are $9.95 and $12.95. Tapered legs (shown in photograph above) are seated in molded-in sockets by friction fit. Note reinforcing ribbing on underside of chair. Metal stiffening cross-piece is held securely to legs by nylon plugs that fit into punched-out slots (shown by circles).

When the year-end pundits sit down to analyze plastics progress in 1961, the successful commercial introduction of injection-molded polypropylene chairs will rank among the major milestones of the year . . . and here are some of the major reasons:

- The chairs, according to knowledgeable industry observers, represent, in terms of shot weight, the largest polypropylene moldings to date: 3 lb. and 3 lb. 11 oz., respectively, for the models currently being made.
- They constitute polyolefin's first major penetration into the general seating field. True, molded high-density polyethylene chairs have scored impressively in school furniture and counter stools. But these were limited and specialized applications; and, besides, those chairs had seats and backs molded separately. The new polypropylene chair is aimed at the entire seating market in all its ramifications. Significantly it is a one-piece, contoured molding.
- With 1962 sales forecast at 1 million units, the chairs will account for annual resin sales in the neighborhood of 3.5 million lb. during their first full year of commercial production. As this article goes to press, the chairs are being made at a rate of 10,000 units per week.

It took three years of machine development, mold design, material evaluation, and exhaustive testing—at a cost of close to $\$\frac{1}{2}$ million—to bring the chair to market. But as a result of this careful preparation and planning, consumer acceptance has been so immediate and enthusiastic that the molder has been hard put to keep up with orders, and is presently negotiating for an Eastern manufacturing site to supplement his operation on the West Coast.

The two models currently being produced are

PP chairs moving fast

Their light weight, virtual indestructibility, and low price are winning sales at a rate that may account for some 3.5 million lb. of resin in 1962

an arm chair and a side chair available in eight colors. The chairs are molded in single-cavity molds on an 800-ton injection machine especially built for this application. Cycle time ranges from 50 to 60 sec., depending on which chair is being run. Average wall thickness for the products is 0.160 to 0.185 inch.

Molded into the underside are reinforcing ribs and four sockets which accommodate four tubular steel legs. Wedgeshape vanes molded into the outside of the sockets and running into the underside of the seat serve to distribute weight and minimize stresses at the points of leg attachment. Legs are seated in their sockets by simple friction fit. To assure their stability and rigidity, a metal cross piece is secured to slots punched into the legs. Molded nylon plugs, attached to the cross piece, fit into these slots and lock the entire assembly securely in place. It takes just a few minutes to put a chair together.

The chairs are now being distributed through 50 warehousing distributors in the furniture field, restaurant distributors on the East and West Coast, and hotel and medical supply houses. Other institutional markets are expected to be added later. Retail prices are $9.95 for the side chair and $12.95 for the arm chair. Additional models, including a latticework unit, a baby high chair, a rocking chair, stack chairs, and several others, are scheduled for introduction in 1962.

Retailers report that the new chairs sell easily because of their demonstrable qualities. For instance, a heavy person can be seated in the chair, tilt back on its two rear legs, and sway from side to side without damaging the chair in any way. Very few other chairs, **(To page 208)**

MOLDED side chair seat is removed from 800-ton injection molding machine especially built for this application. The seat of this chair is molded on a 50-sec. cycle.

SIDE CHAIR undergoing torture test. A 165-lb. weight is dropped on seat while air-actuated piston hits back of seat. This is repeated 720 times per hour. After 190 hr. of testing, chair showed no sign of wear.

FULL SHOT of ball point pen barrels being removed from a 16-cavity mold. Mold uses a geometrically balanced cavity layout, trapezoid cross-sectional runners, and single pin-point gating. Shot weighs 8 ounces.

Precision parts mass produced

Parker has achieved this for pen components through judicious material selection, sound processing techniques, and firm standards of quality control

By P. C. Johnson*

As specialists both in the mass production of plastics parts (as many as 100,000 units a day) and in fabricating to close tolerances (in some cases, on the order of ±0.0005 in.), pen and pencil manufacturers such as The Parker Pen Co. have much of significance to contribute to the technology of the plastics industry. A close look at the plastics components currently in use by Parker points up some unique departures in materials selection, parts design, and processing.

Choosing a plastic

Because of the part geometry and usage peculiar to pens and pencils, considerable in-plant testing is necessary to supplement supplier's technical data. And the results to-date have turned up some interesting aspects of the problems of choosing a plastic.

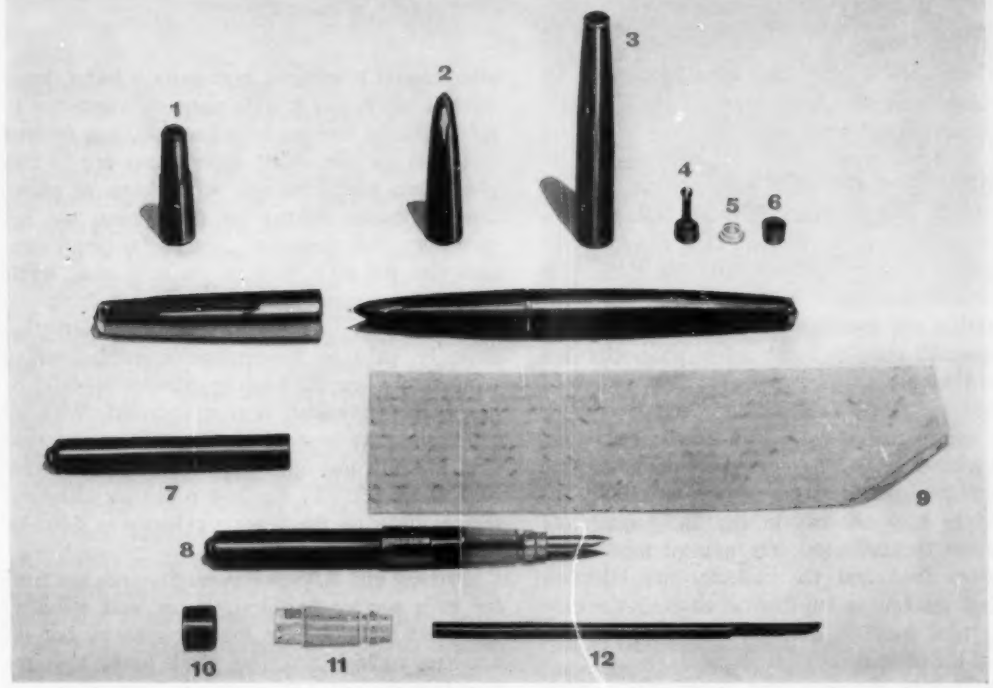
Chemical resistance, for example, is one of the more important prerequisites looked for. Writing inks will chemically attack most plastics—varying in their effect from causing a mild surface stain to severely warping or completely dissolving the plastic. Current writing inks used will have either an aqueous- or a spirit-soluble base and will vary in acidity from a pH of 3 to 11. The standard ink resistance test used is to completely immerse small cylindrical plastics parts in the inks for two weeks both at 73 and 150° F. Parts are then charted as to changes in dimensions, weight, and color before and after immersion. (See table on p. 99).

In determining mechanical durability, on the other hand, designers and manufacturers lay emphasis on the so-called "hoop strength" of the various plastics. While a plastic may have exceptionally good tensile strength, its properties in thin, cylindrical sections (such as pen barrels) may change radically. According to Parker engineers, for example, ABS (acrylonitrile-butadiene-styrene) and impact-acrylic are toughest in sisde-wall thicknesses of 0.70 in. and over; below this dimension, they lose much of this toughness. This falling off in strength is not as noticeable with the cellulosics. A typical test for determining hoop strength involves driving a steel taper of 22° included angle down into the gate end of a fountain pen shell until the shell ruptures.

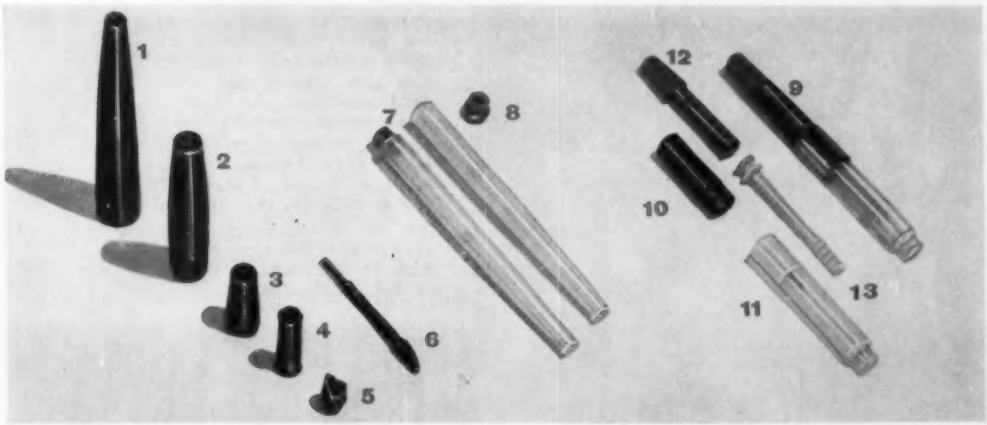
Surface appearance also comes in for a good deal of in-plant testing. To determine surface gloss retention, for example, a fast, inexpensive method utilizing a 2-lb. fibre drum fitted with an S-shaped canvas pocket has been devised. The test moldings are simply loaded into the pocket along with the abrasive media (*e.g.*, keys, coins, sand, etc.). The pocket is clipped shut, the cover replaced, and the drum is mechanically rotated on a ball mill for 30 min. to 2 hr.; the molded parts' surfaces are then visually compared. Even

*Plastics Research Laboratory, The Parker Pen Co., Janesville, Wis.

Materials selection



EXPLODED VIEW of Parker's top-of-the-line "61" fountain pen, illustrating extensive use of selected plastic components in this writing instrument. Components are shown laid out around a finished pen (center) with metal cap removed. **1)** Injection-molded ABS inner cap; **2)** collector shell with nickel decorative insert, molded from high-impact acrylic; **3)** pen barrel, injection molded of high-impact acrylic; **4)** valve plunger (ABS); **5)** valve seat (molded PVC); **6)** valve guide (ABS). Two small decorative "tassies," fabricated from cellulose nitrate rod stock, are used at the ends of the pen. Parts numbered from 7 through 12 are components of the ink-supply system used for the Parker "61." They include: **7)** metal cell case for ink, with Teflon coating which, being hyarophobic, sheds ink when pen is dipped in bottle for filling and does not have to be wiped off; **8)** fully assembled cell case, collector and nib system; **9)** perforated cast vinyl foil, 0.001 in. thick, which is coiled within cell case and produces capillary filling system used on this pen. Produced by a confidential process, it includes tapered, minute ridges, graduated in size, which provide required spacing between layers when the thin layer of vinyl film is coiled for insertion in case; **10)** gasket, injection molded from 6/6 nylon; **11)** collector, machined from cast acrylic stock; **12)** is the "61" ink feed, also machined from cast acrylic stock.



PLASTIC PARTS used in the Parker "45" and the two types of optional ink systems available with it—the throw-away cartridges (center) and the reservoir converter unit (at right). Pen parts, all produced by injection molding are: **1)** barrel, high-impact acrylic; **2)** inner cap, ABS; **3)** the collector shell, high-impact acrylic; **4)** nipple, ABS; **5)** nib collar, ABS; and **6)** feed, high-impact acrylic. Injection molding of feed marked a first for the pen industry. Plastics parts for the two ink systems are: Throwaway cartridge —**7)** the assembled unit and the linear main body of cartridge after removal of **8)** plug, non-linear PE, dry-colored for ink color code. Refillable reservoir converter unit—**9)** assembled; **10)** assembly sleeve, and **11)** reservoir shell, both polypropylene; **12)** drive button, and **13)** piston, both made of ABS.

slight differences in surface gloss retention can be detected in this way, particularly if black, opaque test samples are used.

A range of thermoplastics

Virtually every commercially available thermoplastic material is put to use in the design of the company's pens and pencils. The list already includes the following:

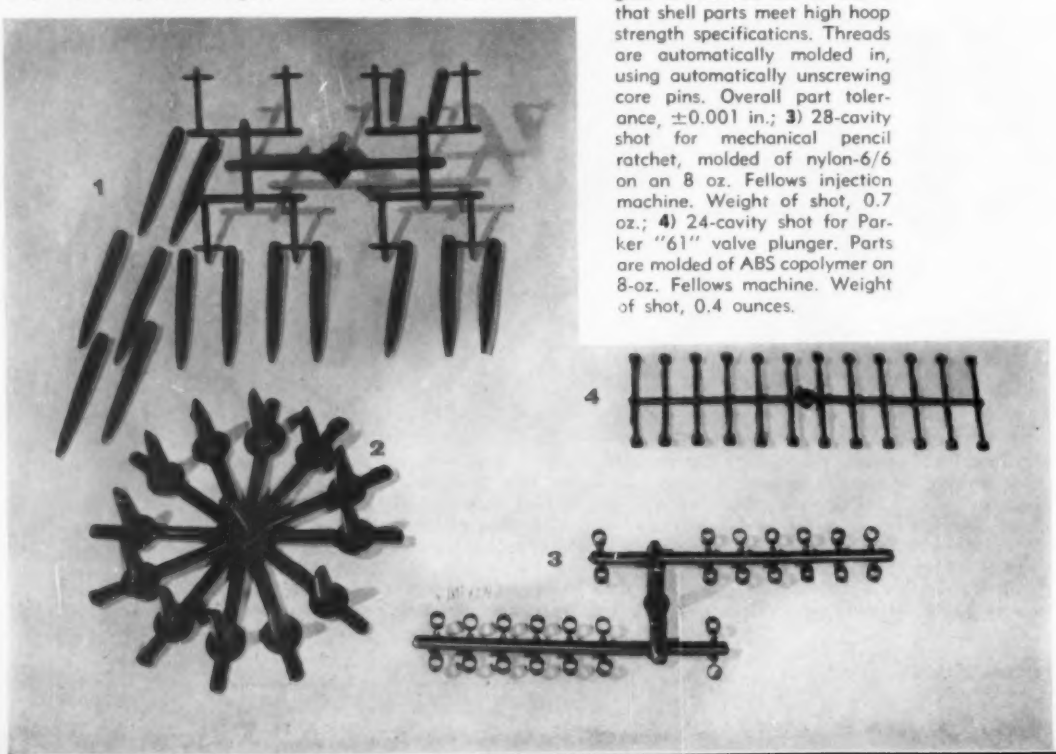
Acrylics and modified acrylics: Excellent luster, dimensional stability, and aging properties are prime reasons for use; shells, barrels, and feed sections are major applications. On two models, parts are machined from cast acrylic rod stock (which is strain-free, has no imperfections such as air bubbles, and offers the surface wettability required to hold the ink in the finely machined spaces in the collector). On a third model, the one-piece feed and the collector are injection molded—an innovation that cut costs, in the case of the feed by 50% over machining, and in the case of the collector, by 80 percent!

Cellulosics: Butyrate and propionate, which offer greater toughness, high surface luster, long-term stability, and a wide range of viscosities to meet specific end-use requirements, are favored materials for use. Most applications are in ball point pens where there is no problem of plasticizer extraction by the ink (ball points use ink cartridges and, therefore, there is no direct contact with the ink). New to the field is a "mint-flavored" butyrate that masks the characteristic butyrate odor. In molding propionate, attention must be paid to temperature control; holding temperatures on the heating cylinder at 440° or less (420° is typical) is recommended. With all cellulosics, the best results have been obtained with formulations having a heat distortion value of 150 to 160° F. (at 264 p.s.i.) to withstand temperatures on the heating cylinder at 440° or dealers' showcases.

Styrenes and ABS polymers: Styrenes are used for their surface hardness, luster, and stability. The ABS plastics have more toughness, but do not have as high a surface gloss. Some high-impact styrenes and ABS materials have an opaque

Balanced mold design

PARKER'S consistent use of the balanced mold principle to insure production of uniform parts is illustrated by this close-up view of four typical shots from the company's injection-molding department. Note very ample runner systems and gates that are used. **1)** 16-cavity shot for Jotter barrels of cellulose propionate. The 16-cavity shot weighs 2.5 oz., is molded in an 8-oz. Lester horizontal machine. Inserts are automatically loaded on core pins pneumatically; **2)** collector shell for Super "21" of high-impact acrylic. This 2.6-oz. shot is molded on an 8-oz. HPM machine. Note heavy ring-type gates. These parts are deliberately molded extra long, then the weaker portion near the gate is trimmed off to insure that shell parts meet high hoop strength specifications. Threads are automatically molded in, using automatically unscrewing core pins. Overall part tolerance, ±0.001 in.; **3)** 28-cavity shot for mechanical pencil ratchet, molded of nylon-6/6 on an 8 oz. Fellows injection machine. Weight of shot, 0.7 oz.; **4)** 24-cavity shot for Parker "61" valve plunger. Parts are molded of ABS copolymer on 8-oz. Fellows machine. Weight of shot, 0.4 ounces.



white-to-yellow natural resin color which, when pigmented into dark colors, produce parts which lack a deep lustrous color due to blushing.

Polyolefins: Excellent chemical resistance and toughness are prime reasons for the use of polyethylene (mostly in internal parts). Major use is in ink cartridges where visibility plus low moisture vapor transmission rates are important. In most of these applications, linear PE is used for the cartridge case, low-density PE for the end-plug (which must be pierced when it is placed in the pen and must form a liquid-tight seal). On one model pen, where the ink cartridge is a converter unit (see photo, p. 97) that can be "worked" to be refilled, polypropylene took the nod because of its toughness, high-impact properties, stress-crack resistance, and translucency.

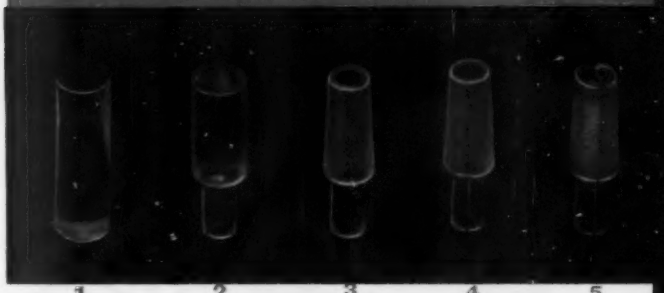
Nylons: These materials (both 6/6 and 6 types) are used in applications where exceptional toughness plus low coefficient of friction are needed. Care must be taken when engineering nylon parts, since the material undergoes dimensional changes when operating in a wet-dry environment.

Fluorocarbons: By applying fluorocarbon coatings to a metal substrate, a unique ink-shedding surface is created. Because of high angle of liquid contact on the plastic, ink will not adhere.

Vinyls: Flexibility plus long-term aging, even after prolonged contact with aqueous writing inks, have boosted its use in ink reservoir sacs and various seals and gaskets. Because of the resistance requirements dictated by the inks that are used, DOP plasticizers, and lately epoxy-type plasticizers, are preferred.

Epoxies: As a high-strength adhesive that is not attacked by writing inks, the epoxies are put to wide use in bonding plastic to metal and plastic to plastic in a number of vital areas.

Automatic machining



STAGES in fabrication of Parker "51" collector from cast acrylic stock include: **1)** material centerless ground to rod and blanked off to proper length; **2)** blank counter-bored, diameter stepped down, and part turned and faced to length; **3)** second counter-boring operation, followed by rough profiling; **4)** part grooved and slit longitudinally; **5)** part circumferentially grooved, deburred, cleaned, washed, and dried. Some 13 operations on automatic machines are required to fabricate this intricate component. Its tolerances include bore, ±0.0005 in., length, ±0.003 in. The 24 fins are 0.010 in. thick and are spaced 0.010 in. apart.

Methods of forming

Injection molding, machining, and casting form the bulk of processing operations. Because the various pen and pencil (**To page 210**)

Effect of writing ink on nine thermoplastics[a]

Type	Percent change Stored at 73° F. Length	Diam.	Weight	Percent change Stored at 150° F. Length	Diam.	Weight
ABS copolymer	No change	−0.12 (Slight stain)	0.68	1.1	0.20 (Slight pitted surface, stained)	4.83
Acrylic	0.22	0.36 (Very slight stain)	1.70	−0.51	0.50 (Very slight stain)	2.80
Cellulose acetate butyrate	0.73	1.13 (Slight stain, crazed)	6.97	2.18	−10.7 (Slight stain, crazed)	1.97
High-impact acrylic	0.15	0.25 (Very slight stain)	1.55	0.25	0.40 (Slight stain)	1.70
Nylon	—	1.90 (Slight stain)	3.80	—	3.40 (Very slight stain)	7.70
Polyacetal	—	0.09 (Stained)	0.37	—	0.59 (Surface attacked, stained)	−1.10
Polycarbonate	−0.29	No change (Very slight stain)	0.26	0.29	No change (Stained)	0.45
Polypropylene	0.30	No change (Very slight stain)	0.17	0.52	−0.05 (Very slight stain)	0.55
Styrene-acrylonitrile	No change	No change (Very slight stain)	0.47	−0.58	0.58 (Pitted, cracked)	2.87

[a] Ink soak tests results obtained after 8 weeks' immersion in blue-black aqueous ink (pH 3.0). Data compiled on injection-molded test cylinders 0.5-in. O.D. by 0.375-in. I.D. by 1.375-in. long. Minus (−) values indicate shrinkage.

New kit brings powdered polyethylene into homes and schools as a medium for a unique form of artistic expression

Bake a picture

FIRST STEP in creating a PE picture is to draw on the bottom of a baking pan with crayon or flow pen. Any number of colors may be used, and sketch may be outlined or colored in.

On the cover of this issue of MODERN PLASTICS appears the first printed reproduction of a new art form using a new art medium—polyethylene powder "baked on" and then peeled off of an ordinary cookie sheet!

And while our cover is a sophisticated piece of work especially commissioned from a famed artist (see p. 102), the same and other art forms, using the same materials, can be created by any child, housewife, artist, school, physical therapy specialist—anybody, including industry. The materials are easy to handle; the tools and methods are simple; the results, depending on talent, are always exciting, frequently gorgeous.

Development of powdered polyethylene (PE) into an art form is the work of Revell Inc., Venice, Calif., known as a leading maker of plastics scale-model kits. Revell will introduce kits containing the needed materials and equipment under the tradename Plastik-Art. The process is a sort of do-it-yourself version of the Engel Process (see MPI, March 1960, p. 86), and Spencer Chemical Co., exclusive licensee of that process in the U.S., worked with Revell on the development.

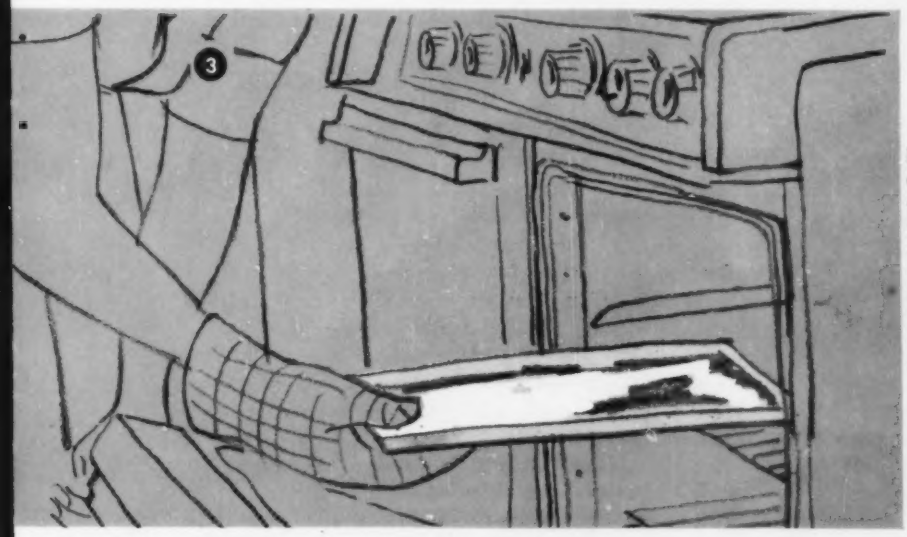
The first step in creating a PE picture is to draw an outline of the intended picture, using drawing crayons or flow pens, on the inside base of a metal baking pan or Pyrex dish. The crayon design should be applied quite heavily.

Next, a bit of cooking or machine oil is spread around the edges of the sheet as a sort of mold release agent. The drawing is then completely "filled out" to a depth of about ⅛ in. by being spread with translucent or colored polyethylene powders. This preparation is then placed in an oven that has been pre-heated to between 250 and 450° F. Under this heat, the polyethylene powders flow together and fuse, and the drawing on the base of the tray is absorbed into the plastic. The picture is fused in less than 5 min., and can be sufficiently

with PE

THE COVER: This impressionistic "cityscape" was created in Plastik-Art from which negatives for the printing plates were shot directly. For details on the artist, see p. 102.

POWDERED PE is sprinkled into the baking pan after the edges of bottom have been oiled. Pan is filled to depth of ⅛ in. with the plastic material, which is supplied along with coloring agents in the special kit.



BAKING takes only 5 min. in an oven preheated to between 250 to 450° F. As the powdered PE is fused by the heat, it absorbs the crayon or ink sketch from the bottom of the pan. After a cooling period of 5 min., the finished work may be removed from the pan for framing or bonding to other pieces to create three-dimensional objects.

DECORATIVE USES for finished art are possible because the plastic materials can be cut with scissors or easily sewn. Here, sewn to lamp shade, translucent nature of material provides back-lighted view when lamp is lit.

cooled in another 5-min. period to permit its easy removal from the tray. The result is a shimmering translucent picture in which the drawing on the tray has been transferred to and through the plastic, so that it can be seen from both sides. Trimmed with scissors, the pictures are textured and colorfully translucent, and are reminiscent of stained glass.

Variations of this "painting" technique are innumerable. By foregoing the use of flow pen or crayon, the more proficient artist can create a picture with the polyethylene powders alone, applying them to the pan in the same way he might apply paint to canvas.

Dramatic collages may be created by embedding glass beads, PE pellets, buttons, metallic pieces or any other non-flammable materials as the picture begins to shimmer in the oven, and then, lightly covering the embedments with additional polyethylene powder.

Utilization or display possibilities of the complete Plastik-Art are more varied than with other finished art products. For example, the picture can be cut out with scissors (PE "paper" dolls are definitely a possibility), heat-bonded or sewn to other PE pictures to produce interesting effects and three-dimensional objects, fabricated into simple printing blocks, or post-decorated with acrylic-based paints, metal flakes, and many other natural materials.

Revell's Plastik-Art will come packed in 1-lb. cylinders of the translucent PE powder. These will retail for $2 per pound. A pallet of six dry colors for self-coloring of the translucent material will be available for $2.00.

Initial marketing of Plastik-Art material will strongly emphasize educational art through school distribution. Weber Costello Co., Chicago Heights, Ill., is exclusive distributor for the product in the school market. Coupled with this plan will be work with youth groups, adult groups in community centers, and art stores.

For the plastics industry, Plastik-Art represents a novel consumer application of raw material and processing technique. But it may represent more. It is not inconceivable that what was borrowed from industry to create a kitchen-oven art form may return to the molding room. For if powdered PE can be decorated while fusing in a baking pan, who is to say that it cannot be similarly—and profitably—decorated while being fused in a commercial molding operation?—**End**

The cover artist

Brooklyn-born, 47-year-old, artist Ted Gilien has created murals for government buildings throughout the United States. Several of his works have become a permanent part of the National Archives. During the war he served as a combat artist for the United States Army, and was on the first team to enter Hiroshima and Nagasaki after the bombing. His brilliant work brought him to the attention of General MacArthur and he was assigned to the Artists Staff of HQ, Pacific Theatre.

After the war Gilien's work won him national renown. His paintings are now in over 300 private collections. The landscape on the cover of this issue was commissioned by Revell Inc. to serve as an example of what polyethylene can do as an art medium in the hands of a talented artist.

FACE MASK is outstanding feature of humidifier design, permits direct inhalation for more effective treatment. Injection molding of polypropylene provides lightweight, comfortable fit. Adjustable head strap is made of vinyl.

FUNCTIONAL components of humidifier inculde: (clockwise from top) six-vane impeller and its cap of high-impact styrene; drip sticks of polyethylene sheet; and fill opening cap of low-density polyethylene.

Humidifier uses 7 different plastics in 17 components because

only plastics offered the necessary wide range of physical properties combined with light weight, ease of fabrication, and high-style appearance that was desired for this appliance.

The Model 240 Cool-Mist room humidifier was recently introduced by the John Oster Mfg. Co., Milwaukee, Wis. The complete appliance, measuring approximately 11 by 11 by 9¼ in. high, weighs only 6 lb. for convenient portability. The 17 plastics parts included in the unit assembly are molded or fabricated from the following: polypropylene, medium-impact styrene, high-impact styrene, reinforced nylon, polyethylene sheet, vinyl tubing and sheeting, and polyester film.

A unique and practical feature of the Model 240 humidifier is its Humid-I-Mask attachment. When connected to the top of the unit by flexible tubing, the mask conducts water vapor directly to the nose and throat. Polypropylene was specified for the injection-molded one-piece mask because of its ability to resist boiling temperature for sterilization. Its flexibility also insures a comfortable fit to the user's facial contours. Other properties qualifying the material for this component include its light weight, glossy molded finish, and resistance to breakage. An adjustable head band, the die cut from flexible vinyl sheeting, holds the mask securely to the face.

The basic housing of the humidifier, injection molded of medium-impact styrene, consists of three parts—the tan base and cover and an upper dome, molded in a beige color. The base serves as a water **(To page 216)**

ABS, acetal, and vinyl chloride make possible

UNIQUE DESIGN FOR

ALL-PLASTICS construction of rotary hand pump assures corrosion-free service, permits unique design which avoids bringing mechanical drive mechanism into contact with liquids.

An engineering approach to the far-ranging design potential of plastics can pay off handsomely in arriving at a truly superior new product. A case in point: the specification of three thermoplastic materials by Craftneeds, a division of Superior Tool & Grinding Inc., House Springs, Mo., in the original design of its first proprietary product—a unique, rotary-action boat pump.

The three materials used are acrylonitrile-butadiene-styrene (ABS), acetal, and vinyl chloride. Each provides complete resistance to salt water corrosion, perhaps the most important requirement set up for the new pump. Furthermore, use of a plastic material for the pump's two housing halves permits this assembly to be solvent-cemented together to form a tamper-proof, floatable pump unit. And, in addition, use of flexible vinyl components provides a means of completely isolating the drive mechanism from the fluid being pumped, a feature not found in similar existing pumps, and of separating the pump into two independently-operating chambers for a continuous flow of fluid.

The ABS material affords high impact and tensile strength for the two housing halves, two piston halves, compression rings, and the rigid suction hose parts supplied with one model of the new pump. Acetal, because of its high load-bearing capabilities, is used for the two-part handle unit and for the drive mechanism, consisting of a barrel cam, a sleeve ring, and a small driver which rides in a groove in the cam. The vinyl parts include a bellows, diaphragm, and two exit valves. Major components of the pump are shown singly and assembled in a cutaway model in the photo at right.

Unique acetal constructions

Although the use of acetal in a pump is not new, the assembly of one acetal part directly against another is unique in the new pump. Such assemblies occur in two areas: between the barrel cam, driver, and sleeve ring of the drive mechanism; and between the handle and its knob. A barium-base grease lubricant is applied to these areas to assure their friction-free operation. Several hundred hours of motorized testing of the pump, at speeds far above normal hand operation,

HAND PUMP

has shown that the acetal-against-acetal assemblies will stand up under heavy pump usage.

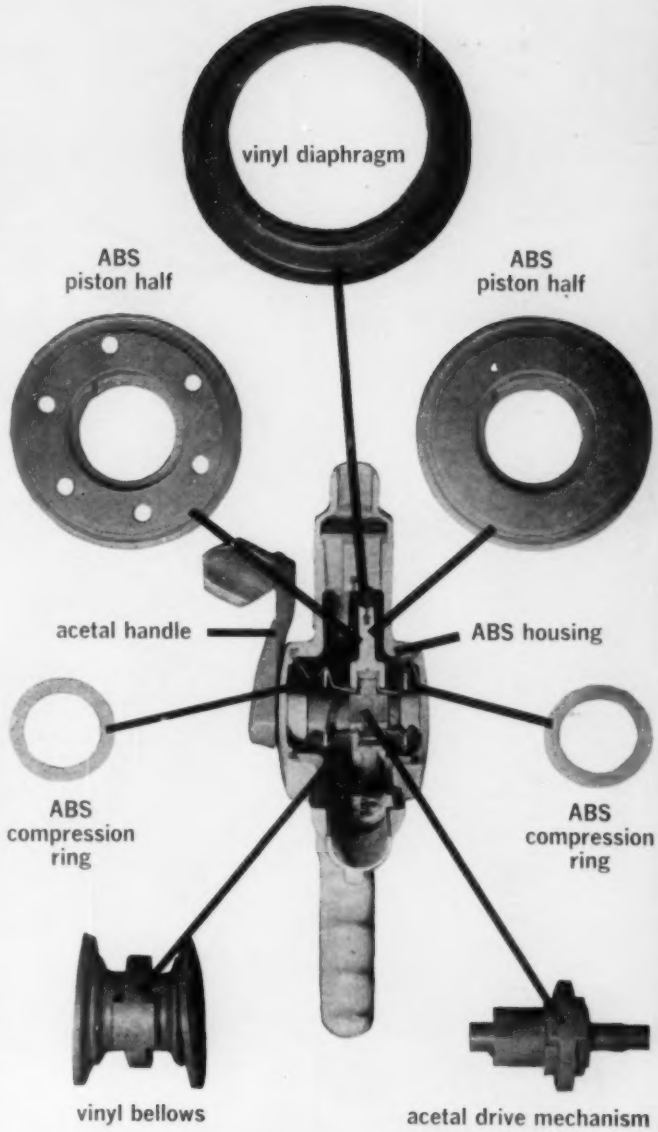
The vinyl components are produced by low-pressure injection molding in closed aluminum molds. This operation is done by Craftneeds, which also does its own tooling. The vinyl parts have particularly important functions in the new pump. For example, separation of the pump into two independently-operating chambers is accomplished by the circular vinyl diaphragm, the edges of which are sandwiched between the two piston halves and housing halves when they are solvent-cemented together. The discharge of fluid from each chamber is controlled by two vinyl valves, permitting discharge of fluid from one chamber while the other is sucking up fluid. And the vinyl bellows completely encloses and protects the drive mechanism from the fluid being pumped.

How pump works

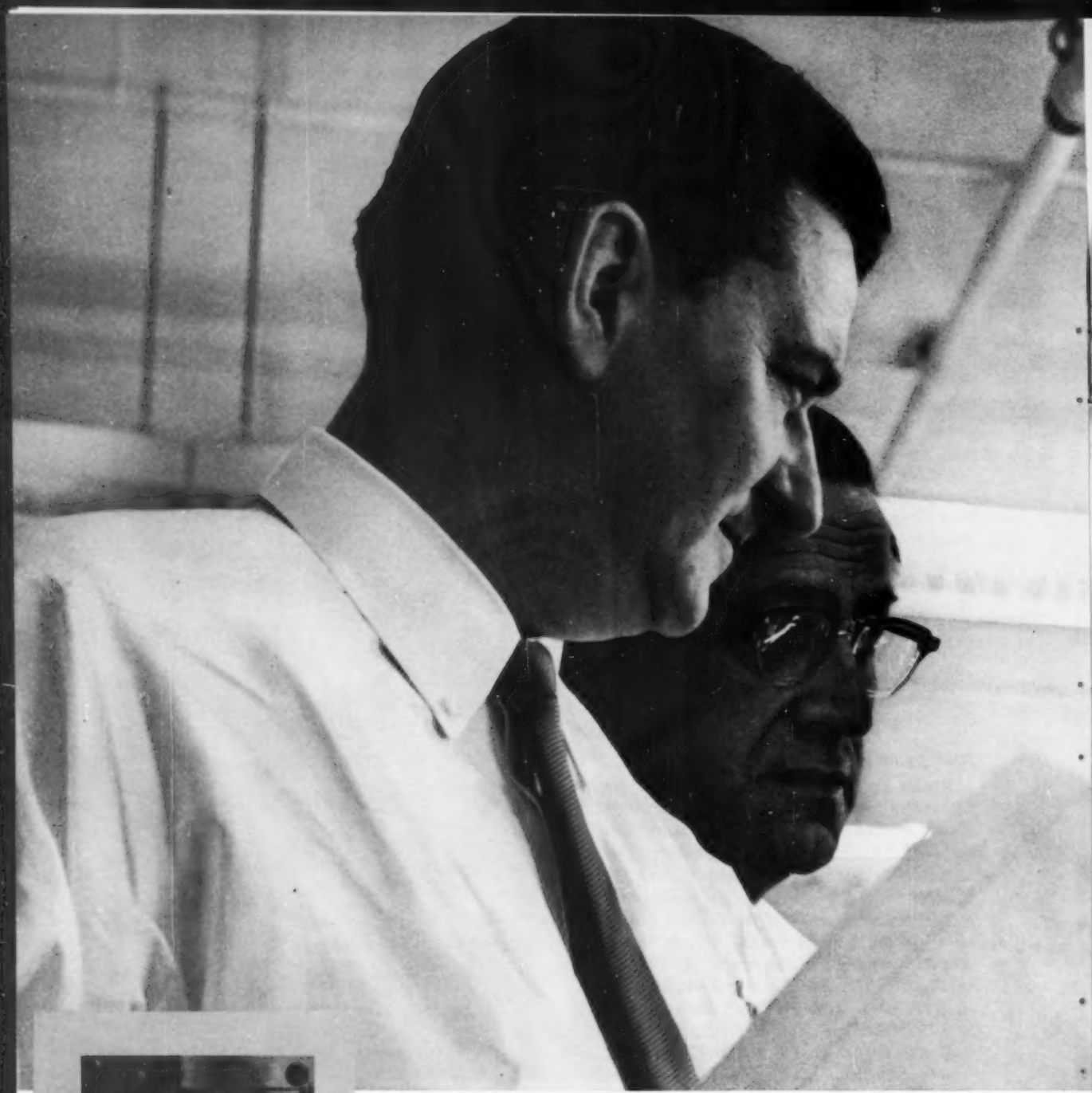
Rotary operation of the pump handle pushes the acetal driver back and forth along the spiral groove molded into the cam. This action sets up transversal motion of the piston, which produces suction on the side of the pump it moves away from, and pressure on the side it is moving toward.

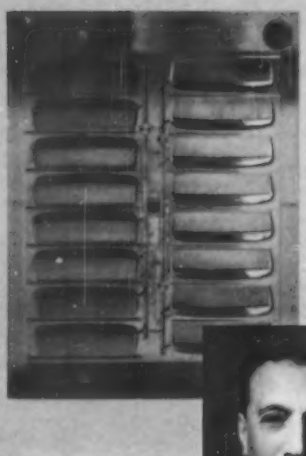
The new pump, named the Rotoflo, can pump up to 4 gal./min., a volume greater than that of pumps costing twice as much. The retail price of the pump is $9.95 for the portable model equipped with three 11-in. rigid suction tubes and $10.95 for the mountable unit equipped with a 10-ft. flexible suction hose and fittings. In addition to such boat applications as evacuation of bilgewater, transfer of fuels and oils from dock tanks to boat, or aeration of bait tanks, the Rotoflo can pump air for inflation of beach toys and mattresses, and can even pump plating solutions, bleaches, and other chemical solutions for non-boating purposes.

Credits: Rotoflo pump designed by Hyde Engineering Co., Cincinnati, Ohio. Housing components injection molded by Yardley Plastics Co., Columbus, Ohio. Handle unit, piston halves, and compression rings molded by St. Louis Plastic Moulding Co., St. Louis, Mo. Drive mechanism parts molded by Plastic Moldings Corp., Cincinnati. Kralastic MH (ABS) resin supplied by Naugatuck Chemical Div., U. S. Rubber Co., and Delrin acetal resin by E. I. du Pont de Nemours & Co. Inc.—**End**

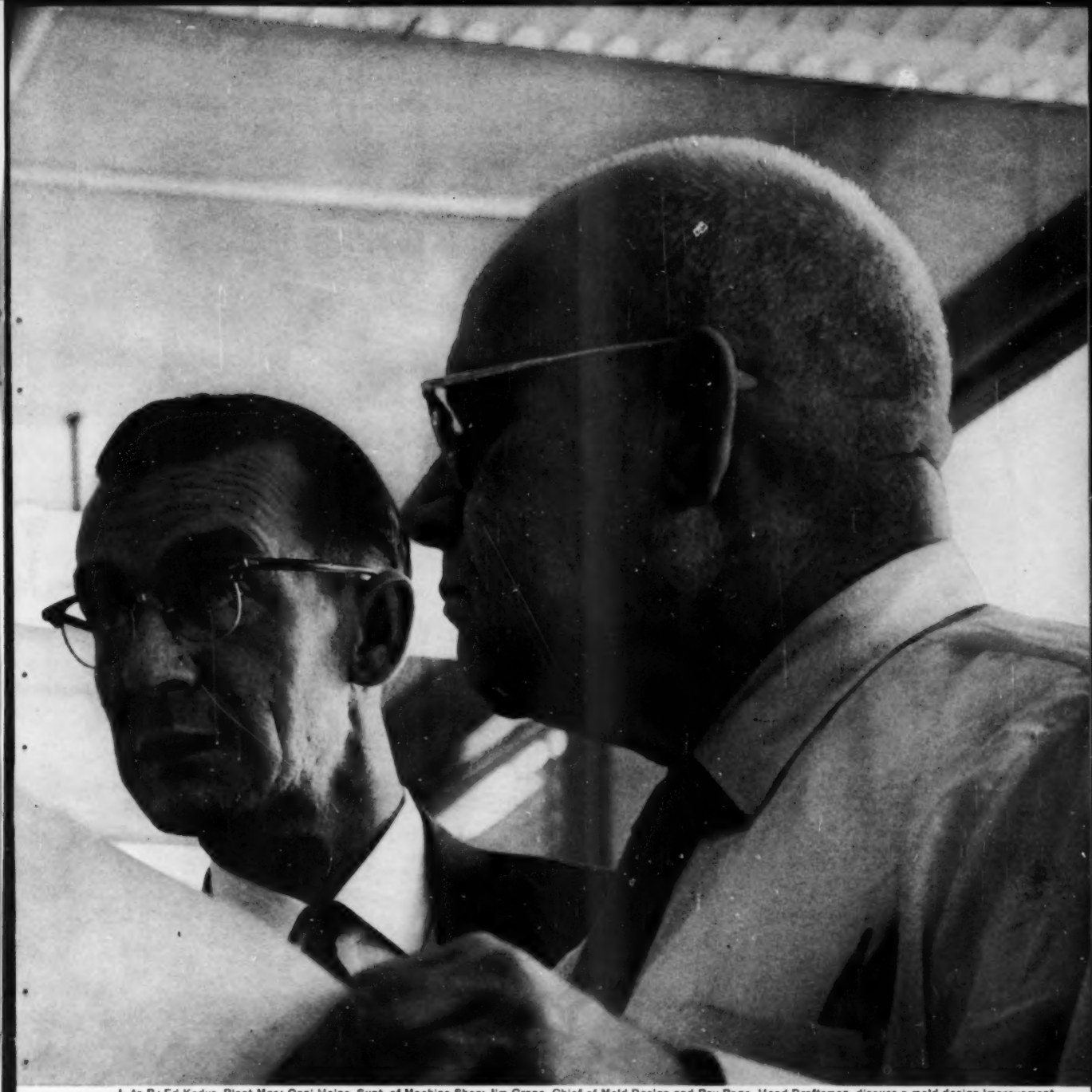


HOW PUMP IS ASSEMBLED: drive mechanism is slipped in place in bellows; the two piston halves are slipped over bellows and solvent-cemented together; compression rings are placed in bellows; entire sub-assembly is then laid in one half of housing and second housing half is solvent-cemented to its counterpart; ends of bellows are pulled through openings in housing and sealed in place with solvent-cemented ABS caps. As shown, pump compartment to right is pumping out while compartment to left is exerting vacuum.





"These men helped solve a customer's mold design problems. Maybe they can solve yours," says Joe Foster.



L. to R.: Ed Kodys, Plant Mgr.; Onni Heino, Supt. of Machine Shop; Jim Crane, Chief of Mold Design and Roy Page, Head Draftsman, discuss a mold design improvement.

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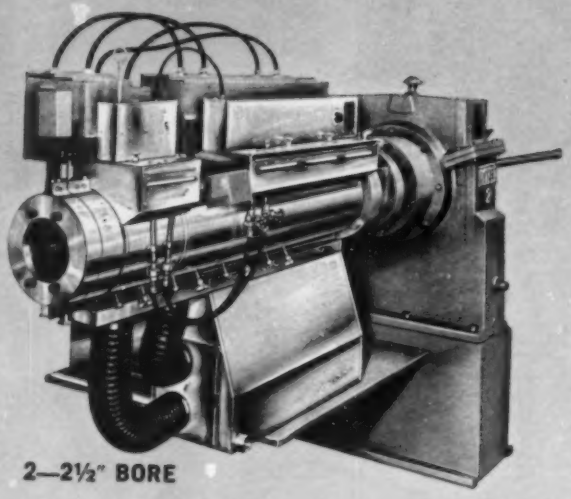
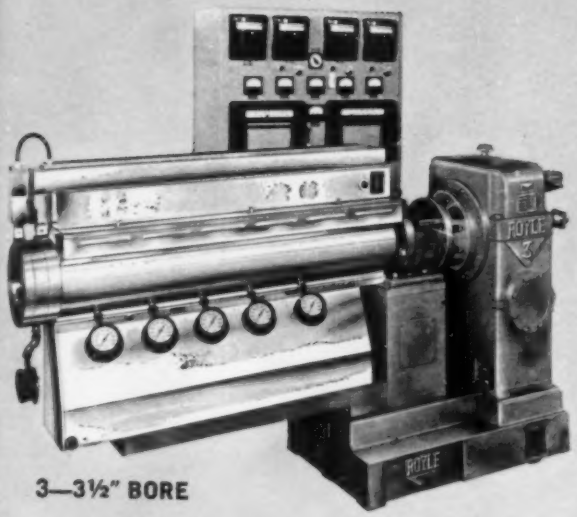
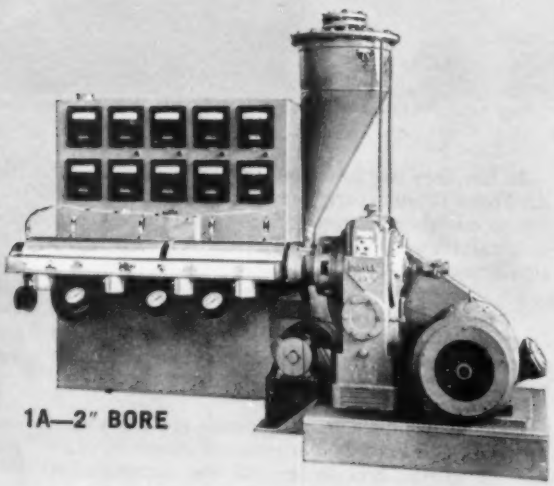
Royle Spirod extruders designed for Technical Service Laboratories



2—2½" BORE



3—3½" BORE



1A—2" BORE

George R. Smoluk, ENGINEERING EDITOR

PLASTICS ENGINEERING*

PROCESSING • FABRICATION • PRODUCT DESIGN • TOOL AND EQUIPMENT DESIGN

Molding vs. casting for epoxy encapsulation

For certain electrical applications, transfer molding techniques can put additional money in your pocket

By Gerard B. Rugg†

Engineers, responsible for the design and development of electronic components, are constantly faced with the problem of choosing the epoxy formulation and the method of encapsulation which will produce a resin-packaged component of the required quality at the lowest unit cost. In many cases, choice of the resin formulation will be governed primarily by the physical and electrical properties the finished part is required to have. In some of these cases, the resulting resin formulation will have processing properties which may limit the choice of processing method. There are applications where the electrical properties of the part are not critical, permitting considerable leeway in the formulation of the resin so that it may be modified to suit a desired method of processing. When this is the case, the engineer has his choice of at least three basic methods of surrounding a component with a protective jacket of resin: dip coating, casting, or molding around the part.

Dip coating may be accomplished by using either a liquid resin or a powdered epoxy compound via the fluidized bed technique. Since no molds are used, it is a relatively inexpensive method of encapsulating parts. However, control of the coating thickness and the resulting over-all dimensions of the coated part is relatively poor, and the thickness of coating which may be applied in one pass is limited. In addition, the use of fluidized bed techniques is limited to parts which can withstand the preheating of the component which is required in this method. These and other shortcomings have limited the usefulness of this process.

Casting is the most widely used and the most versatile method of encapsulation. In this method the part is placed in a mold, evacuated to remove air from the interstices of the part, and resin is poured into the mold. After an initial cure, the embedded part is removed and

Table I: Applications best suited to casting

1. **Small quantities under 10,000 pieces per year.**
2. **Pressure and/or temperature sensitive components, such as transistors, vacuum tubes, wax-impregnated capacitors, components with thermoplastic lead wire or insulation, magnetic cores.**
3. **Units required to operate continuously at very low or very high temperatures—above 160° C. or below −30° C.**
4. **Components containing large metal cores or otherwise subject to severe thermal shock stresses.**
5. **Components where it is desirable to obtain intimate impregnation of wire windings in the embedment process.**
6. **High voltage applications where absolutely void-free embedments are necessary to avoid corona.**
7. **Highly flexibilized epoxy systems.**
8. **Large embedments (dependent on press capacity, but certainly those requiring more than 10 cu. in. of compound).**

Table II: Requirements generally suitably met from either casting or molding

1. **Operating voltage below 2000.**
2. **Continuous operating temperatures ranging from −30 to +155° C.**
3. **Most chemical environments wherein epoxides are suitable, such as most acids and alkalies, alcohols, hydraulic fluids, salt water, etc.**
4. **Military applications involving MIL-I-16923, Types B, C and/or MIL-E-4970.**
5. **Underwriters Class A, B, temperature ratings.**
6. **Components such as resistors, capacitors, transformers, switches, solenoids, relays, rectifiers and combinations of these.**

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finished by curing in an oven. The process is sometimes referred to as "potting" when the resin is poured into a component, which is mounted in a shell or container, which is an integral part of the finished component and which serves to contain the liquid resin during the pour.

Molding differs from casting in that the resin, usually in the form of a plasticated melt, is forced into the mold under heat and pressure. The epoxy compound used in molding is normally in the "B" stage and is usually preformed from a powder or granules before it is loaded into the molding machine, which converts it to the plasticated melt. The molding process closely resembles transfer molding, which is used with phenolics and other thermosetting resins.

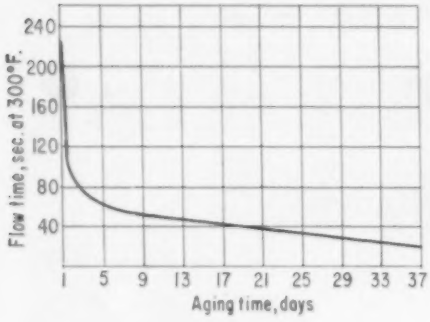


FIG. 1: Graph illustrating relationship of B-stage molding compound flow properties, expressed as seconds of flow at 300° F. to the time at which the compound is aged at 70° F. Data are for the formulation described in Table III.

Table III: Comparison of typical general-purpose casting and molding formulations

Type of formulation	*Components*	*Percent by weight*
Casting	Low-viscosity epoxy resin[a]	47
	Silica flour[b]	47
	Triethylene tetramine[c]	6
Molding	Unmodified liquid epoxide[d]	26
	Silica flour[b]	66
	Zinc stearate	1
	4-4' methylenedianiline	7

[a]Such as Ciba 506, Bakelite 2795, etc. [b]Low iron and moisture content, 325-mesh grade. [c]Added just before use. [d]Such as Jones Dabney 510, Dow 331, etc.

Table IV: Finished properties of a casting and a molding compound

Property	*General-purpose casting compound*	*General-purpose molding compound*
Specific gravity	1.6	2.0
Tensile strength, p.s.i.	10,000	8,000
Flexural strength, p.s.i.	12,000	14,500
Izod impact, ft. lb./in. of notch	0.3	0.25
Water absorption, 24 hr.	0.1	0.08
Adhesion	Very good	Fair
Heat distortion point, °F.	180	275
Percent wt. loss, 7 days, 300° F.	0.75	0.15
Thermal conductance Cal/Sec./C./cm.²/cm. $\times 10^{-4}$	4.0	7.0
Coefficient of linear thermal expansion, $\times 10^{-5}$	3.9	3.6
Dissipation factor, 1 mc.	0.03	0.03
Dielectric constant, 1 mc.	4.2	4.1
Dielectric strength short time, v. per mil	450 to 500	400 to 450
Arc resistance	140 to 180	140 to 180
Volume resistivity, Ohm, cm., 73° F.	1.5×10^{15}	1.3×10^{15}
Volume resistivity, 150° F.	3.1×10^{14}	7.1×10^{14}
Volume resistivity, 200° F.	1.4×10^{12}	1.0×10^{14}
Volume resistivity, 266° F.	10×10^{10}	5.0×10^{12}
Volume resistivity, 300° F.	2.8×10^{9}	6.9×10^{11}
Volume resistivity, 392° F.		4.5×10^{10}

Above properties were obtained using the appropriate ASTM method by Wabash Magnetics Inc., or U. S. Testing Laboratories Inc., for Wabash Magnetics Inc.

After many years of experience using the casting method for the production of epoxy resin-encapsulated electrical coils, the Deluxe Coils Div. of Wabash Magnetics felt that coils for some applications might lend themselves to the use of a more economical method of production. In 1958, after a comprehensive experimental program and investigation, the company pioneered production lines for the transfer molding of these components. Based on their combined experience with both casting and molding techniques used in the same applications, it has been concluded that, in certain non-critical applications, coils can be encapsulated with adequate finished quality by molding at costs significantly lower than with casting.

As implied previously, molding is not suitable for all applications. Those applications in which the end-use requirements are so severe that they require rigid adherence to a special formulation may be limited to production by casting since the resin formulation will not lend itself to the modifications required to make it moldable. In this case, casting provides more production flexibility. For example, casting is the preferred method when the components to be embedded are too delicate to withstand molding pressures. Casting is also generally preferred when the epoxy resin formulation is designed for highest temperature resistance. Table I, p. 109, lists uses in which experience has shown that casting is better than molding. Table II, p. 109, lists applications which can be produced equally well by either method and in which the use of molding may result in an economic advantage.

Compounds

The formulations of a typical casting compound and a typical molding compound are compared

in Table III, p. 110. As can be seen from Table IV, p. 110, which compares the finished properties of these two epoxy resin formulations, they could be used interchangeably in many applications as defined in Table II. Note that the molding compound has a significantly higher filler content to adjust the flow of the resin to the molding process, as well as to increase thermal conductivity.

Casting resins of the type described will usually have a pot life of about 30 min. at room temperature. Normally the cast part may be removed from the mold after an initial mold cure of about 30 min. at 140° F. The cure time is kept as short as possible to allow a fast turnover of molds and reduce production cost. Compounds of this nature are widely used for the encapsulation of small components. The exothermic nature of these fast-curing systems generally limits their use to applications where cross sections of the resin envelope do not exceed 0.5 inches. After the initial cure in the mold, the parts are usually subjected to a further postcure of about 2 hr. at 250° F. to develop the desirable properties of the fully cured resin.

Whereas the casting compound is a pourable liquid, the epoxy encapsulation molding compound is a dry, free-flowing solid in powdered or granular form. Molding compounds of the type described in Table III will usually have a cure time of about 1 to 5 min. at a molding temperature of 275 to 325° F. Transfer pressures of 100 to 400 p.s.i. are sufficient for most applications. The low pressure requirement is a major advantage in applications involving the encapsulation of components with delicate and fragile sections. Like the casting resin, the optimum physical properties of the finished epoxy encapsulation may be developed by subjecting the molding to a postcure of 2 to 4 hr. at 300 to 350° F. in an oven. Molding compounds and casting formulations are available from a number of epoxy resin compounders.

If desired, "B"-stage epoxy molding compounds may be prepared by the molder himself in a relatively easy fashion. First, the required weights of resin, filler, and other additives, with the exception of the amine hardeners, are mixed in a heavy-duty propeller-type or dough mixer. After the batch is thoroughly mixed, the melted hardener is added and mixed in for about 5 to 10 minutes. During this stage of preparation, it is essential that the mix temperature be controlled between 110 and 135° F. The reaction is exothermic and the mix should be cooled to prevent an excessive temperature rise. It is wise to experiment with small batches (25-lb.) while gaining experience. After the hardener has been added, the compound is poured into shallow metal trays to a depth of about 0.5 in. and allowed to cool to room temperature. Trays should be coated with a silicone release agent prior to filling.

After cooling, the solidified resin is allowed to age at room temperature until the flow of the aging resin has reached the value desired for molding. The flow which the resin will exhibit when molded at 300° F., expressed in seconds, is plotted as a function of the aging time at 70° F. in days in Fig. 1, p. 110. Data are for the molding formulation shown in Table III. After four days, the flow is in the range of 70 sec. and continues to decrease at the rate of 2 to 3 sec. per day. Generally, the molding compound is usable until the flow falls below a value of 20 sec., in

Table V: Capital and tooling expenses for encapsulating coils by casting[a]

CAPITAL EQUIPMENT[b]	*Coil "A"*	*Coil "B"*
Conveyorized ovens	$ 8,000	$ 8,000
Resin mixing, metering, dispensing and storage equipment	5,500	500
Vacuum equipment	1,500	1,500
Mold release sprayer	500	—
Roller conveyor	900	900
Automatic mold opening device	3,000	—
Sprue cut-off saw	1,000	1,000
Total capital equipment	$ 20,400	$ 11,900
TOOLING COST		
Molds	$ 4,400[c]	$ 2,255[c]
Clamps	2,100[d]	265[d]
Sprue cut-off jaws	500[e]	—
Total tooling cost	$ 7,000	$ 2,520
TOTAL CAPITAL AND TOOLING COST	$ 27,400	$ 14,420

[a]Production rate of Coil A estimated to be 3 million coils per year; that for Coil B, 200,000 coils per year.
[b]Ovens for post curing not included for comparison with Table V. These are required for critical jobs made by either casting or molding.
[c]Cost for 2500 aluminum die cast molds, master dies and mold pins required for Coil A; Coil B requires 300 units.
[d]Cost for 200 mold gaging clamps for Coil A; Coil B requires 25 units.
[e]Cost for 16 sprue cut-off saws for Coil A. None required for Coil B.

Table VI: Capital and tooling expenses for encapsulating coils by transfer molding[a]

CAPITAL EQUIPMENT[b]	*Coil "A"*	*Coil "B"*
Transfer molding presses[c]	$ 26,000	$ 6,500
Preformers[c]	3,600	900
Electronic preheaters[b]	4,800	1,200
Component preheating ovens[d]	1,800	900
Total capital equipment	$ 36,200	$ 9,500
TOOLING COST		
Total mold costs	$ 14,950[e]	$ 2,790[f]
TOTAL CAPITAL AND TOOLING COST	$ 51,150	$ 12,290

[a]Production rate of Coil A estimated to be 3 million coils per year; that for Coil B, 200,000 coils per year.
[b]Ovens for post curing not included for comparison with Table V. These are required for critical jobs made by either casting or molding.
[c]Four equipment units required for Coil A; one for Coil B.
[d]Two equipment units required for Coil A; one for Coil B.
[e]Includes five mold sets each consisting of 16 lower cavities and eight upper cavities.
[f]One mold set consisting of eight lower cavities and four upper cavities.

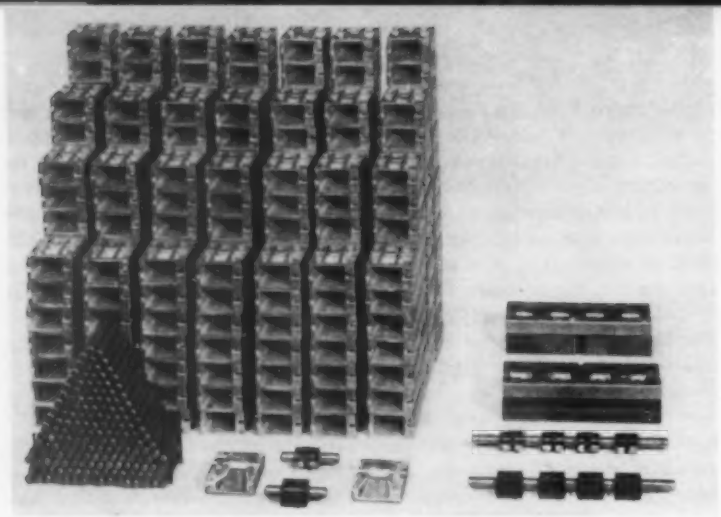


FIG. 2: Fewer dies are required for the molding than for the casting of coils. Heap of dies at left is required to produce the same number of the same part at a given rate as the single mold at right. Each of the casting molds is a single-cavity mold; the transfer type mold at right has four cavities. The encapsulated coils are shown on mold cores at center and at right front.

about 35 days. If the compound is aged or stored at 40° F., its shelf life is extended to approximately 60 to 90 days.

When the resin flow has reached the flow value desired, the material is removed from the trays, and ground into a powder for use.

The compound described in Table III is presented as an example of a typical epoxy molding material; there are many possible variations which will work equally as well for different applications. Other filler materials, resins, and additives can be used to develop special and desirable properties in the compound. For example, the shelf life and cure time of the compound above can be lengthened by a) substituting menthanediamine or diaminodiphenylsulfone for all or part of the curing agent shown; or b) substituting a higher-molecular-weight epoxide resin, such as Shell 1001, for all or part of the liquid resin component. Conversely, cure times and shelf lives will be shortened by a) substitution of an epoxy Novolac resin, such as Dow 438, for all or part of the resin constituent; or b) the use of small amounts (0.25 to 1.0%) of phenol or resorcinol as an accelerator in the formulation (1)[1].

In addition to the use of aromatic amines as curing agents in the preparation of "B"-stage epoxy molding compounds (2), manufacturers' literature also discusses the use of pyromellitic dianhydride (3) and boron trifluoride-monoethylamine complex (4) as curing agents. Phenolic resins have also been used in certain proprietary formulations. However, none of these systems has been found to offer the combination of fast cure time at low transfer molding pressures and temperatures that is available when the aromatic amines are used. In addition, many of the above systems form compounds which are very brittle when molded without reinforcing fibers, and generally require glass or other types of fibrous reinforcement to produce satisfactory products.

The question of whether to make or buy epoxy molding compounds for encapsulation is one to which there is no pat answer. However, several rules of thumb may be used in deciding the issue.

Where small quantities of compound are required or where personnel have limited experience in the handling of epoxies, buying the required compound from an outside vendor is frequently the wisest as well as the most economical course of action.

If large volumes of compound are to be consumed, it is usually more economical for the user to formulate his own materials. The exact volume of production at which this becomes advantageous will differ from plant to plant, depending upon overhead and other in-plant factors.

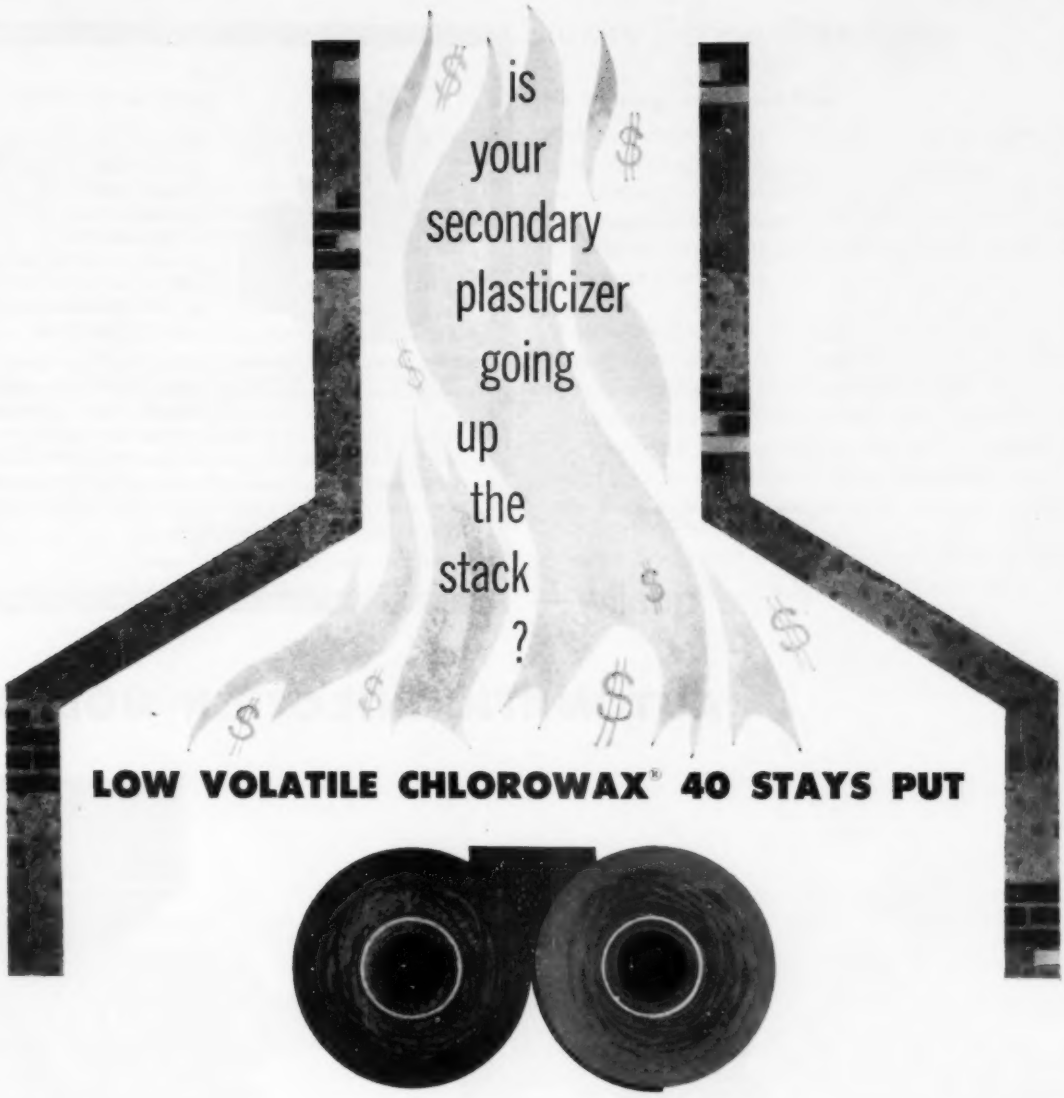
The formulation of his own materials by the molder is especially advisable in those plants where the requirements for each of the end products vary so considerably that the encapsulating formulation must be **(To page 219)**

Table VII: Typical savings possible when using molding vs. casting for the encapsulation of electrical coils[a]

	Cost of casting $/1000	*Cost of molding $/1000*
COIL A		
Capital equipment costs[b]	0.54	0.97
Tooling costs[c]	2.34	4.98
Direct labor[d]	20.70	6.12
Total costs	23.58	12.07
Savings	—	11.51
Total savings	—	$ 34,500
COIL B		
Capital equipment costs[e]	0.95	0.76
Tooling costs[f]	12.60	13.95
Direct labor[g]	54.90	22.80
Total costs	68.45	37.51
Savings	—	30.94
Total savings	—	$ 6,188

[a]Material costs are assumed to be equivalent (See text). Other costs assumed not significant in determination of savings.
[b]Based on 10-yr. depreciation rate, 80% utilization of equipment for this coil during 16-hr./day, 240-day year, and the estimated production of 3 million coils per year.
[c]Based on assumption tooling is amortized over 3-million-coil lot.
[d]Labor per 1000 cast coils is 8.27 hr.; for molded coils, 2.45 hours. Cost of labor estimated at $2.50/hour.
[e]Based on 10-yr. depreciation rate, 16% utilization of equipment for this coil during 16-hr. day, 240-day year, and the estimated production of 200,000 coils per year.
[f]Based on assumption tooling is amortized over 200,000-coil lot.
[g]Labor per 1000 cast coils is 21.88 hr.; for mold coils, 9.12 hours. Cost of labor estimated at $2.50/hour.

[1]Numbers in parentheses designate references at end of article, p. 229.



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Chlorowax 40	.00002
Chlorowax 50	.000015
DOP	.00002
Secondary #1	.00600
Secondary #2	.01200
Secondary #3	.000270
Secondary #4	.00300
Secondary #5	.01030

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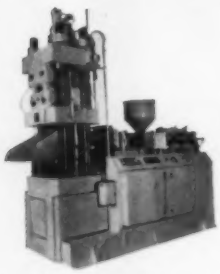

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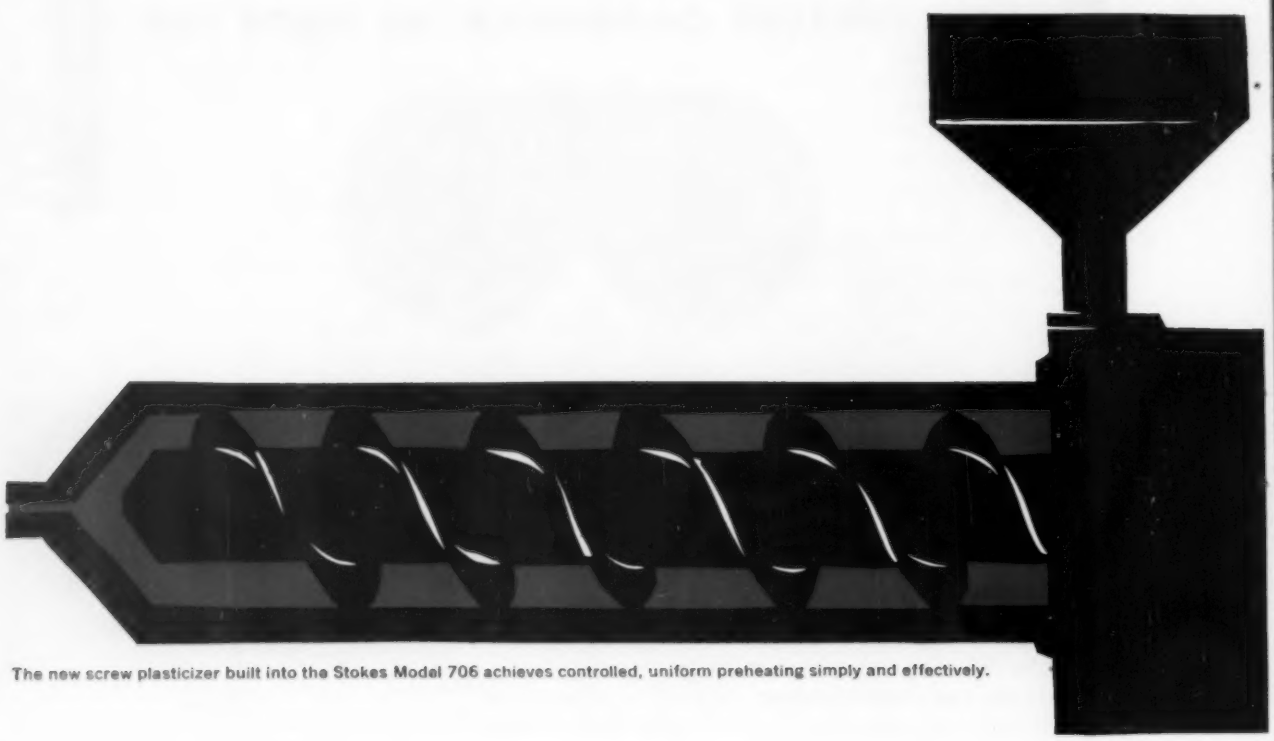

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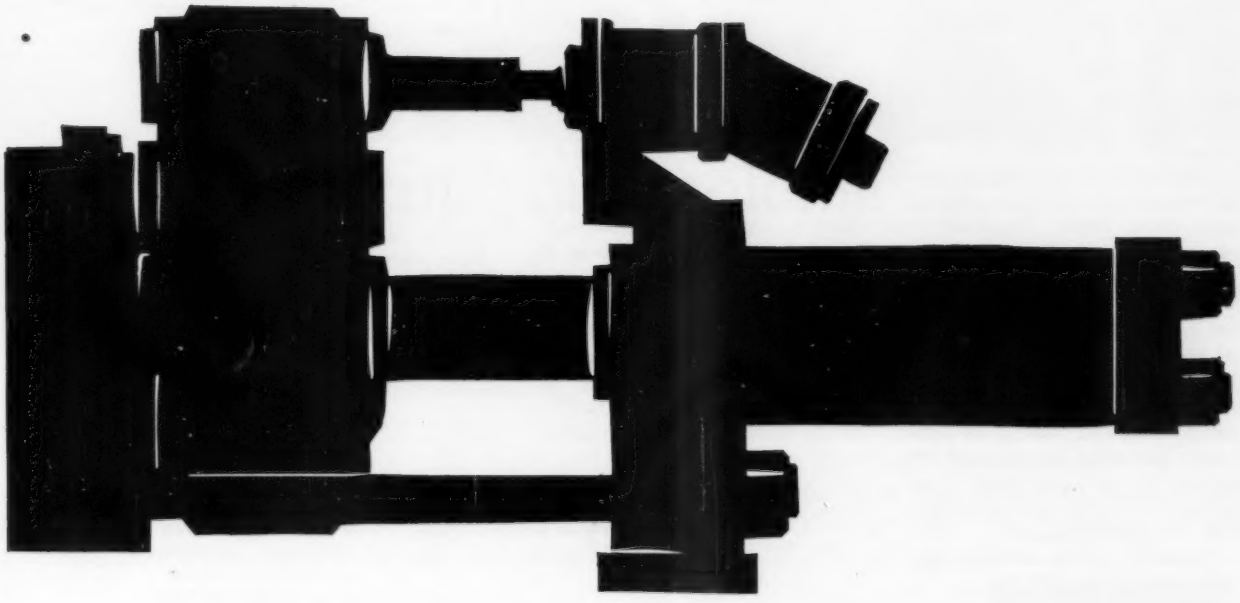

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New light on melt elasticity

By Robert A. McCord* and Bryce Maxwell**

The elastic recovery characteristics of branched and linear polyolefin melts were investigated with the use of a rotational plastometer. The variable effects of temperature, strain magnitude, and stress relaxation before strain recovery were studied as functions of basic structural differences, molecular weight, and degree of side branching. It is proposed that this type of rheological behavior is an important consideration in the flow and deformation of polymers. Examples of fabrication processes are cited where elastic recovery is an important factor for precise control of final dimensions of fabricated items.

Attempts are made to explain the elastic response behavior in terms of structural changes and molecular mechanisms. Two different basic types of recovery mechanism were resolved for branched and linear polymers. The elastic properties of branched polymers are primarily controlled by branch entanglement, and are very sensitive to temperature, causing almost complete decay of elastic recovery at higher-melt temperatures. The elastic properties of linear polymers are controlled by main polymer chain entanglement, and appear to be essentially temperature independent. It is apparent from the large amounts of recovery observed for both small and very large degrees of strain that polymer melts are indeed very elastic.

In recent years extensive effort has been expended exploring the viscous properties of polymer melts. However, the elastic properties have been essentially ignored. Therefore, this work was devoted to study the elastic characteristics (normally associated with solids) of such melts rather than the more commonly studied viscous characteristics (normally associated with liquids).

Such an investigation of the elastic recovery characteristics of polymer melts under conditions of shear strain was expected to provide a deeper insight into the effect of this type of rheological behavior on the flow and deformation of polymers during fabrication. A thorough understanding of the effects of time, temperature, and the effect of rate of loading on these elastic properties is considered important for a "more ideal" treatment of polymers during molding and extrusion operations.

The ensuing study of these elastic and viscoelastic properties involved is based on the interpretation of time-dependent strain recovery data from rapid-straining-rate experiments. It is obvious these data are a function of temperature, the applied strain magnitude, and the amount of stress relaxation which takes place before strain recovery. The procedure involved in straining the melt and measuring its elastic recovery is illustrated diagrammatically in Fig. 1, below.

During the application of strain, there is a time interval between the instant of initial application of the strain and before flow takes place, when the material exhibits behavior that is controlled primarily by its elastic characteristics. A similar behavior is observed during the recovery period after the removal of the straining force. This behavior may be called melt elasticity and is readily detected when thermoplastics are forced through small orifices at high shear rates by measurement of the swelling of the extrudate. This phenomenon is encountered to varying degrees in all fabrication processes where molten polymer is forced through injection nozzles and extrusion dies. Thus a better understanding of the elastic properties of melts can be useful in helping to control such things as:

1. The uniformity of extruded parisons to allow precise control of the wall thickness of blow-molded items.
2. The final dimensions of thick and/or large profile extrusions.
3. The over-all thickness and uniformity of relatively flat areas of injection-molded parts (sink marks) during the low shear stress portion of the cycle as the injection pressure is backed off.

Commercial polyolefins are currently produced in a wide range of molecular weights, degrees of chain branching, and densities. These materials have many properties in common, but also vary considerably in their mechanical behavior. Structurally, these polymers are a complex arrangement of amorphous and crystalline regions whose mechanical properties depend upon the interaction between these two phases (1).[1] The distribution and behavior of these two phases in a polycrystalline material is in turn greatly influenced by the pressure-temperature environment it has been subjected to

[1]Numbers in parentheses denote references at the end of the article, p. 240.

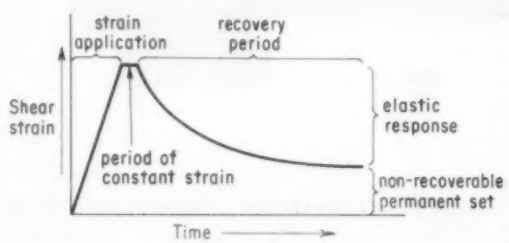

FIG. 1: Diagrammatic presentation of the experimental technique used to study the elastic recovery of olefinic polymer melts. After constant strain, the external stress is removed and the melt recovers under no external forces.

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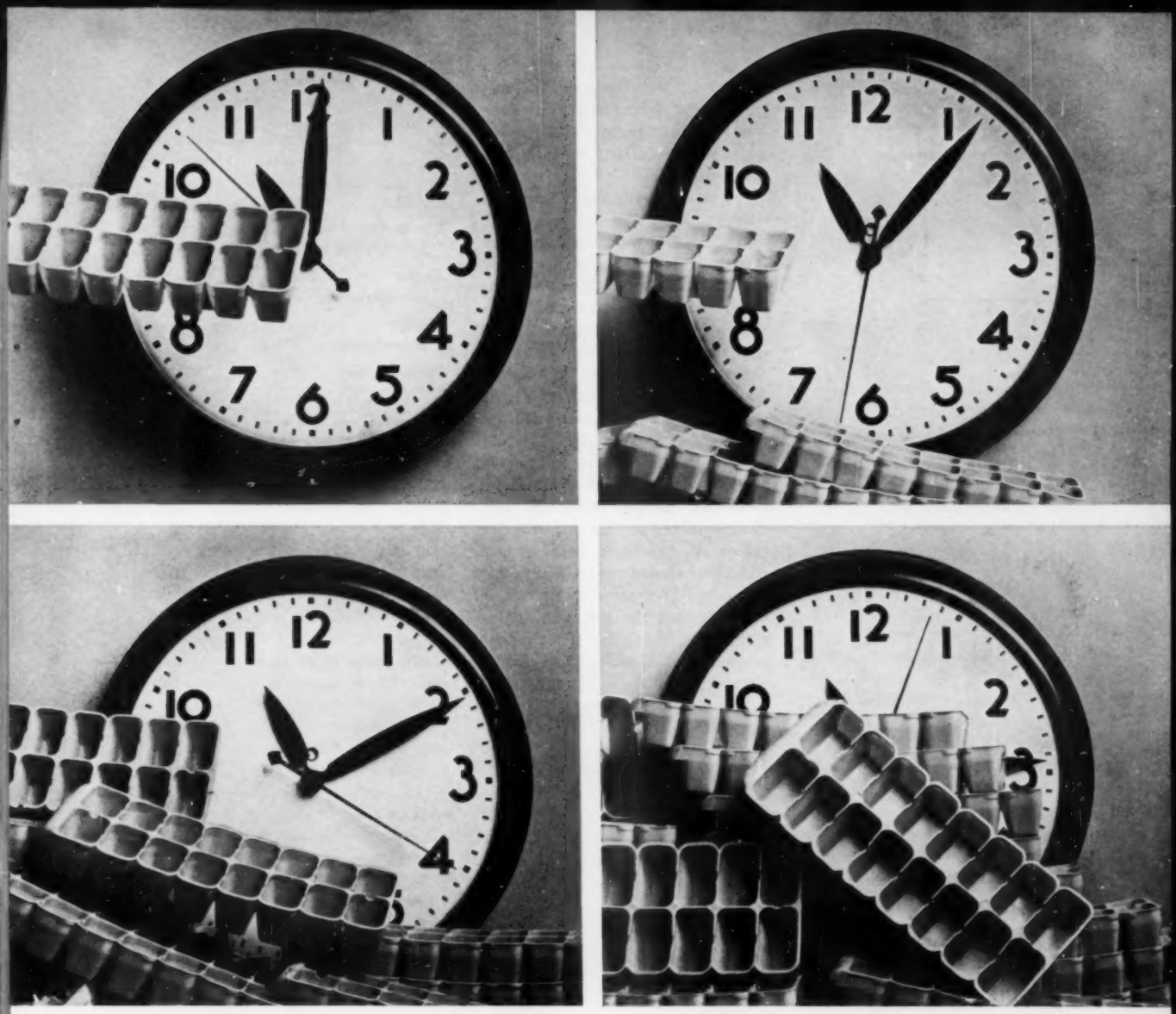

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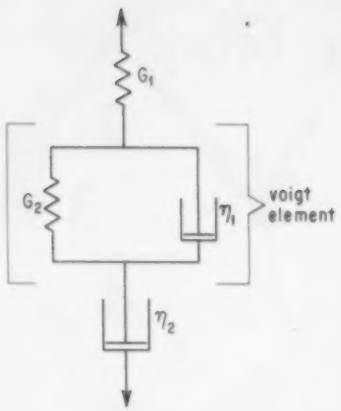

FIG. 2: Schematic mechanical system used to visualize the elastic and viscous elements in viscoelastic polymeric systems.

during its processing history (2). This thermodynamic history, combined with molecular structural factors, greatly influences the mechanical properties of these polyphase materials (3).

This study of the elasticity of polymer melts will concern itself primarily with only the following molecular parameters: 1) density-crystallinity differences; 2) molecular weight; 3) degree of branching; and 4) over-all structural configurations. Effects of molecular weight distribution, the degree of chain orientation, and cross-linking are considered of equal importance and certainly should be included in future investigations of the elastic nature of polymer melts.

Theory

Various theories explaining viscoelastic behavior give insight into the mechanisms involved and the role of structure in the elastic response of polymeric materials. These theories have been developed through the use of analogous mechanical models of viscoelastic systems from which we are able to obtain a crude qualitative picture of the viscoelastic behavior of amorphous linear high polymers (4). Such a mechanical model is shown schematically in Fig. 2, above, and consists of a spring, G_1, a Voigt element, $G_2 + \eta_1$, and a Newtonian dashpot, η_2. This model resolves the total strain response of the system into: a) an instantaneous elastic compliance; b) a retarded elastic compliance; and c) unrecoverable viscous flow. This system, therefore, approximates the viscoelastic behavior of a polymer melt.

When discussing the different responses listed above, the specific aspects of the molecular structure responsible for the macroscopic phenomena of molecular mechanisms should be considered. In unoriented linear polymer melts (amorphous), each flexible long-chain molecule exhibits a random configuration in space such that the average distribution of the chain segments of a given molecule about its center of gravity assumes a Gaussian arrangement. These randomly coiled molecules are closely packed so that adjacent domains of molecules overlap and molecular chains are intimately intermeshed in a complex web. The result is that the entangled polymer chains, much like a pile of entangled ropes, form a strong over-all polymer chain network system.

When a stress is applied to such a system, deformations occur by various simultaneous processes (5). The first is a relatively small, completely recoverable, elastic deformation or strain which reaches its maximum equilibrium value in a very short time. This behavior is exhibited by both crystalline and amorphous materials. This is believed due to the distortion of primary and secondary valence bonds, and corresponds to the instantaneous elastic compliance of the elastic element of the model. (G_1 in Fig. 2). This instantaneous elastic compliance is most readily observed at lower melt temperatures where the "glassy" state behavior, due to "frozen" or fixed molecular configuration, is predominant.

Another deformation process consists of a retarded elastic compliance or time-dependent elastic deformation, which is due to the

Table I: Injection molding conditions for test specimens[a]

Type of material	*Barrel temperature*	*Injection pressure*
	°F.	*p.s.i.*
Low-density polyethylene	350	7500
Ziegler polyethylene	375	7500
Phillips polyethylene	375	7500
Polypropylene	400	7500

[a]All specimens molded on a 1-oz. Watson-Stillman vertical injection press. Cycle and all other molding conditions were held constant.

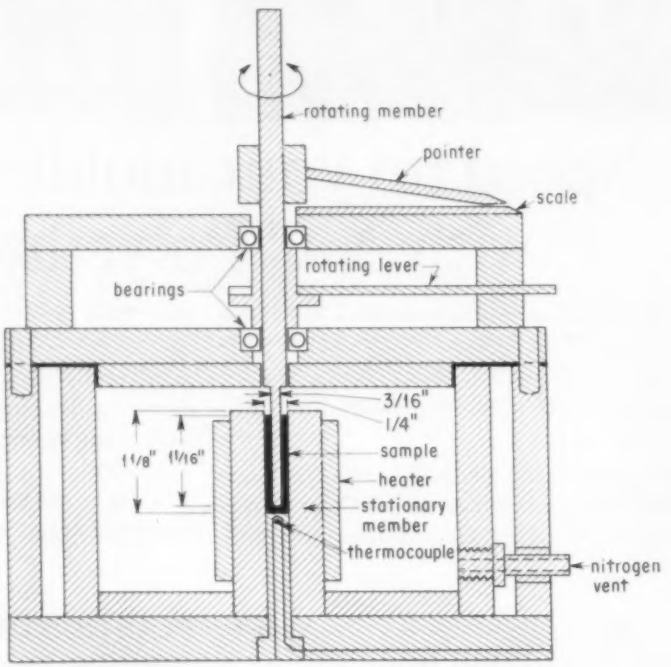

FIG. 3: Cross-section of the experimental apparatus used to study the elastic recovery of olefinic polymer melts.

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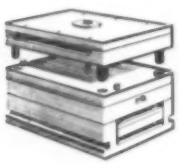

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over-all action of chain entanglements. This behavior is represented by the Voigt element, G_2 and η_1, in Fig. 2. Here the polymer acts like a temporary, crosslinked network with the entanglement points between adjacent chains representing the network junctures. However, these entanglements are not permanent, and the entanglement points will slip past each other after a period of time. Eventually, the system will behave as though the network structure does not exist. During this period of time, the concurrent behavior of both a time-dependent elastic deformation and unrecoverable viscous flow is exhibited. This behavior is represented by the combination of the Voigt element and the dashpot, η_2, in Fig. 2. The former represents the stretching and uncoiling of polymer chains under the influence of the external force, which is very dependent upon the imposed stress and the molecular weight of the chains. The viscous deformation represents the slipping of molecular chains past each other, giving irreversible (non-elastic) flow resulting in "permanent set" after the stress is removed.

In polycrystalline materials at temperatures above their crystalline melting points, the heat induces plasticization, permitting internal rotation of chain segments and the dissolution of crystalline areas where crystallites had formed due to coalignment of polymer chains. As temperature increases, the amount of crystalline material diminishes, but is probably never completely removed. This is particularly true in linear polymers where the increased Brownian movement of chains with increasing temperature may induce conditions, allowing intermittent crystallites to be formed when linear segments of adjacent polymer chains align themselves properly and come into intimate contact. This over-all behavior resembles that of a temporary crosslinked system at temperatures above the crystalline melting point, due to the transient crystallites produced in local regions throughout the polymer mass. Evidence for a similar semi-permanent network system has been presented by other workers in this field (6). Under the influence of increasing temperature, each individual chain molecule of the intertwined assembly wiggles around from one configuration to another. The higher the temperature, the faster is this rotational motion, producing increased chain-to-chain distances which result in diminished structural strength. This is due to the weakening of the **(To page 124)**

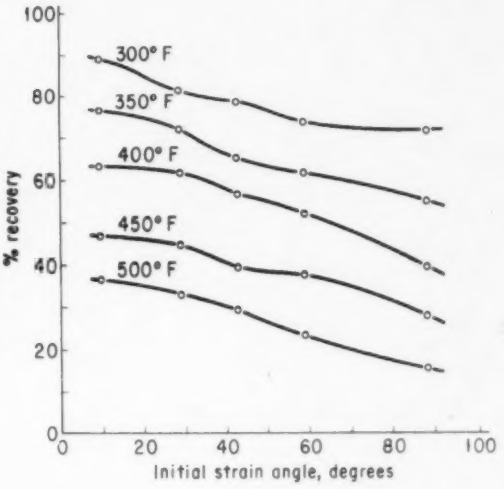


FIG. 4: Elastic recovery of a branched polyethylene melt shown as a function of melt temperature and the initial value of shear strain. Percent strain is initial strain minus final strain expressed as a percent of initial strain. Strain values are in angular degrees.

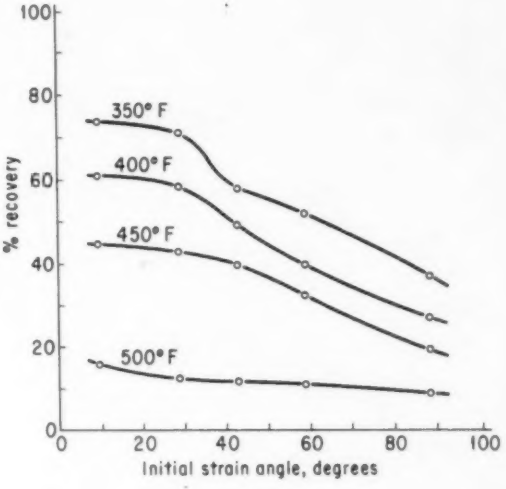


FIG. 5: Elastic recovery of a polypropylene melt as a function of the melt temperature and the initial value of shear strain.

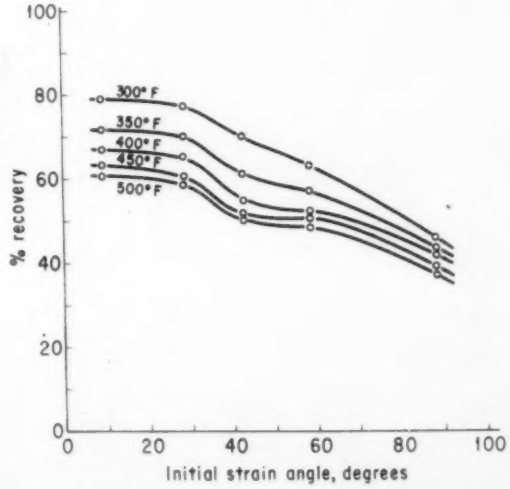
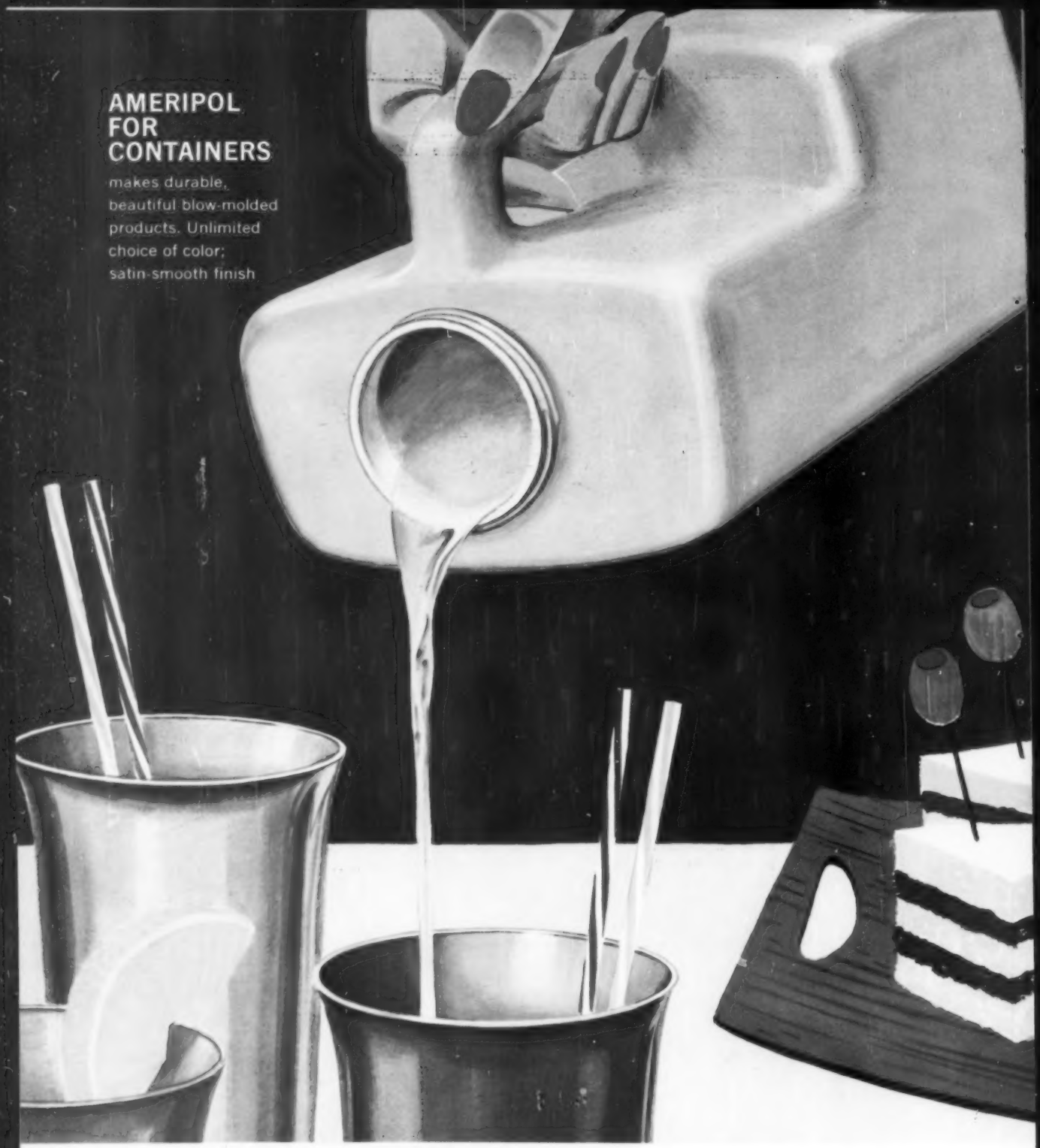


FIG. 6. Elastic recovery of a linear PE melt as a function of melt temperature and the initial value of shear strain.



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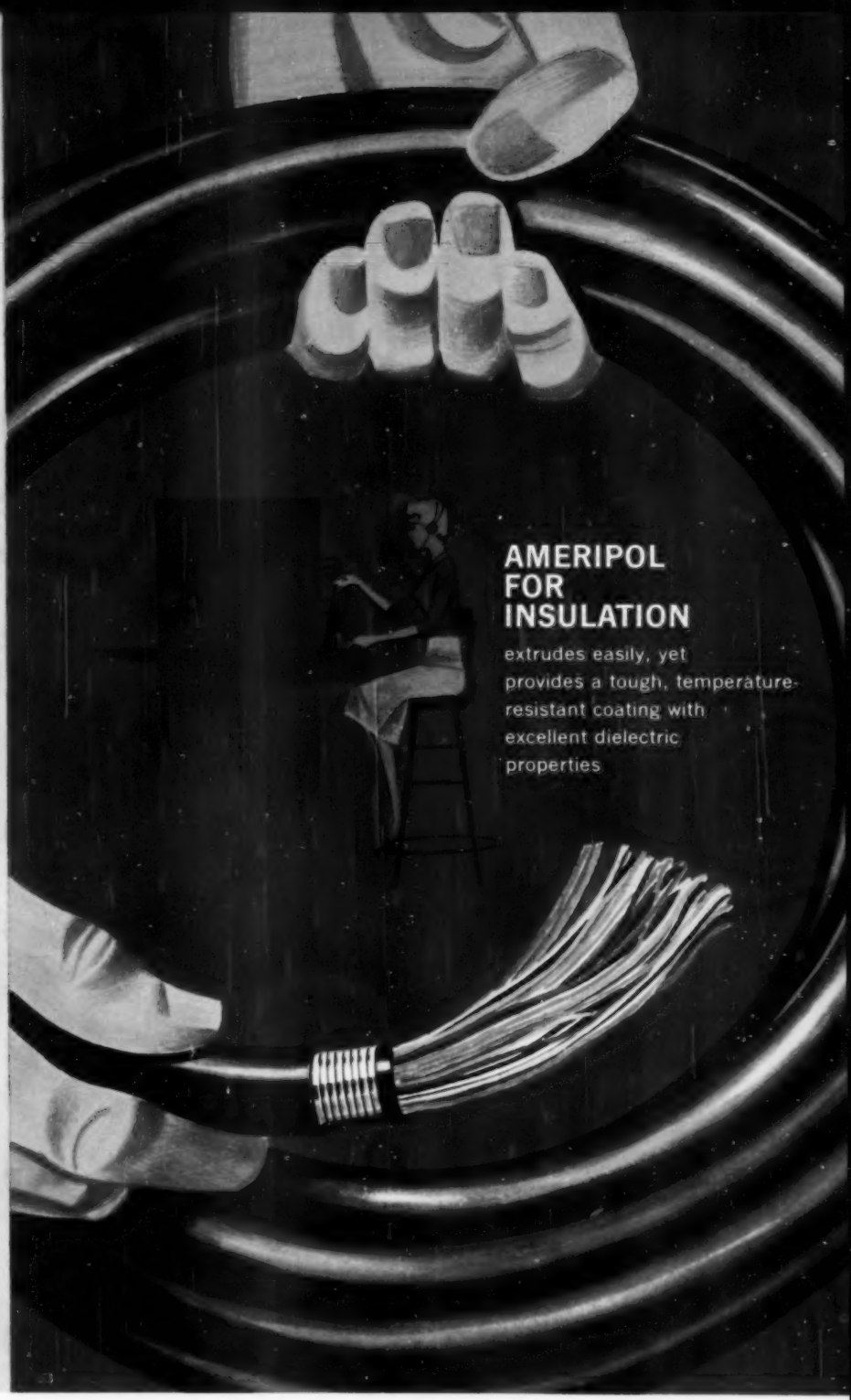

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Table II: Characteristic properties of materials tested

Material	Crystalline melting point[a]	Density	Melt index	Molecular weight[b]	Methyl branches[c]
	°C.	g./cc.	g./10 min.	M_w	
Low-density PE	110	0.920	2.0	—	—
Low-density PE (75)[d]	104	0.914	1.8	510,000	3.30
Low-density PE (76)[d]	112	0.922	1.95	300,000	2.20
Low-density PE (79)[d]	114	0.922	3.3	—	2.00
Ziegler PE (RSV=1.5)[e]	128	0.945	—	90,000	0.67
Ziegler PE (RSV=2.0)[e]	128	0.945	—	130,000	0.78
Ziegler PE (RSV=4.8)[e]	128	0.945	—	420,000	0.74
Ziegler PE (RSV=5.7)[e]	128	0.945	—	530,000	0.90
Phillips PE	135	0.960	0.6	—	0.10
Phillips PE	135	0.960	3.0	—	0.10
Polypropylene	171	0.900	—	—	—

[a]As determined by loss of birefringence. [b]Weight average molecular weight. [c]Per 100 carbon atoms in the main polymer chain. [d]Number in parentheses is code number of Du Pont characterized sample. [e]Reduced specific viscosity value.

forces of the secondary (Van der Waal's forces) bonds.

Alfrey (7) suggests that the compliance associated with different retarded elastic behavior corresponds to the straightening out and orientation of molecular "kinks, curls, and convolutions" of different-sized polymer chains. These long-chain molecules in an unstressed linear polymer are distributed in their statistically-favored half-curled forms and will neither be extended to maximum length nor tightly curled into balls. In this form, there will be local kinks of relatively short segments; bends and curls of intermediate size; and long-range convolutions of the chain as a whole. Under conditions of stress, the stress will act directly upon each unit of the chain via its environment, not merely upon the chain ends. As the stress is imposed on the system, the Brownian motion of the polymer chains is hindered due to the elongated and oriented molecular configurations produced, which favor the formation of crystallite growth in the melt. The stress tends to straighten out the molecules and orient them in the direction of the stress. In this new configuration; the local kinks, the intermediate curls, and the long range convolutions will all be partially oriented. During the transient period when this new elastic equilibrium is being established, the local kinks will straighten out most quickly, the intermediate bends more slowly, and the long range convolutions most slowly of all. This combined action results in a complete spectrum of elastic compliances due to the contributing effort of each molecular mechanism that is acting over different time scales at various rates in order to achieve its equilibrium position.

Superimposed on the effects of temperature and structural response to stress is the very important consideration of the rate of shear application. The total response of a polymer system to a shearing force depends upon the rate of destruction and restoration of the equilibrium structure of the chains. The over-all structural strength of such a system is not only a function of temperature and the molecular parameters involved, but also of the rate of shear application. Thus, if the rate of loading exceeds the rate of chain disentanglement and slippage about the temporary network contact points, it is reasonable to expect chain rupture in the form of mechanical degradation. Due to the viscous nature and the time dependency of the elastic response mechanisms of the complex network structure of polymer melts, the rate of loading is a critical factor in their elastic response. This is

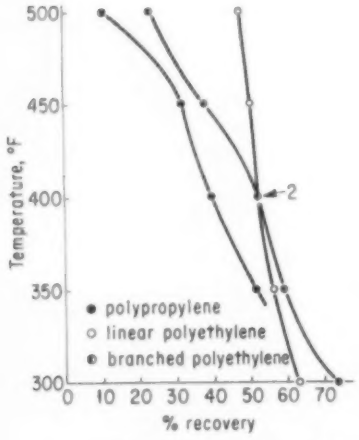

FIG. 7: Variation of elastic recovery of branched polyethylene, linear polyethylene, and polypropylene melts with melt temperature. All curves were obtained by initially straining the sample in rotational shear through a shear angle of 59°.

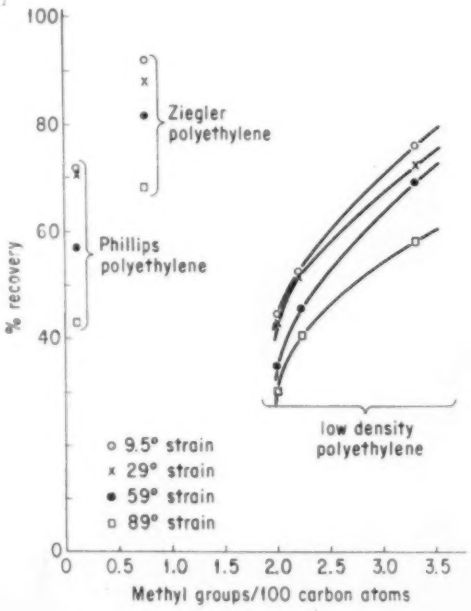

FIG. 8: Data showing the effect of branching as indicated by the methyl group content of linear and branched polyethylene melts on the elastic recovery properties of the melts. All curves were obtained at melt temperatures of 350° F.

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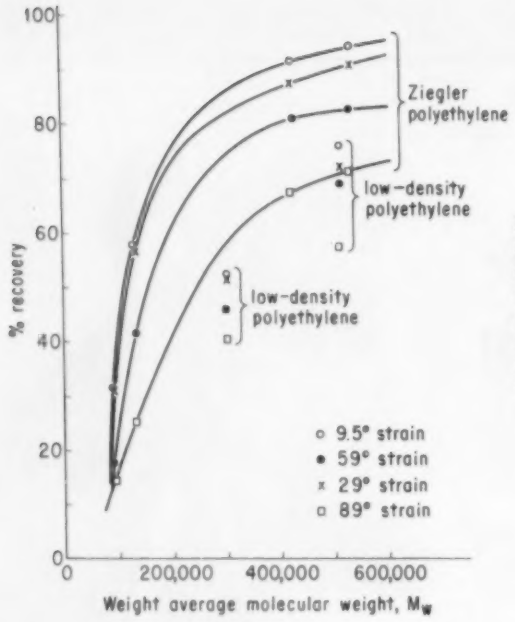

FIG. 9: Relationship between elastic recovery of olefinic polymer melts at 350° F. and weight average molecular weight, M_w, of the polymer at various values of initial strain.

because rapidly applied strains are not distributed uniformly among the elastic elements in the molecule at the same time. For slowly applied strains, the strain is distributed throughout the complete network system, which has time to respond to the total applied strain. Rapid rates of strain are not as destructive to the elastic recovery behavior as slower rates of strain due to the time dependent action of the molecular mechanisms involved.

Uncoiling and slippage of polymer chains will be hindered by the degree of branching present. For highly branched materials, there would be more interweaving of branches, but strictly on a localized scale. Longer, more linear chains will be looped and entangled to a much greater degree over a wider area. If there are short side chains (methyl groups) present at intervals along these chains, they will act much like a knot in a rope as it is slipping through a hole, and will catch at the entanglement points, producing a stronger, more elastic response. If the case of highly branched (lower density) polymers, where branches range in length from one to many carbon atoms (it is even possible to have branches of lengths equal to the main polymer backbone chain), the degree of entanglement caused by branch interweaving on a small localized scale is large; but, due to the shortness of the main polymer chains and the steric hindrance effects of the bulky side groups, there is essentially no long-range entanglement of the main polymer backbone chain acting over a large area. Branch entanglement on a localized scale does not contribute nearly as much to the elastic response of a polymer network system as does the long-range entanglement of essentially linear (higher density) polymer chains.

Fig. 3, p. 118, is a schematic cross-section of the instrument designed and built for this investigation. Called a rotational shear plastometer, it was designed to study the time and temperature dependent elastic behavior of polymer melts and their stress relaxation responses, and is similar to a Couette (8) or Stormer (9) rotating viscometer. The inner circular member is rotated and the outer circular member held stationary. This design was chosen because, in contrast to most studies of melt elasticity which have been conducted under flow conditions (10-11), this study required a static type test where corrections for flow anomalies arising from material flow through orifices and dies are not involved.

This work made no attempt to explicitly describe the strain conditions existing in the shearing area, but was concerned only with relative comparison of various materials at different strain magnitudes and with the degree of recovery that is expressed in percent.

The largest error in the data arises from the difference in the application rate of the straining force from run to run. However, the experimental data can be reproduced within a 5% limit for all conditions used. Analysis of movie films of the experiments conducted at 59° strain magnitude indicates the actual rate of strain is approximately **(To page 130)**

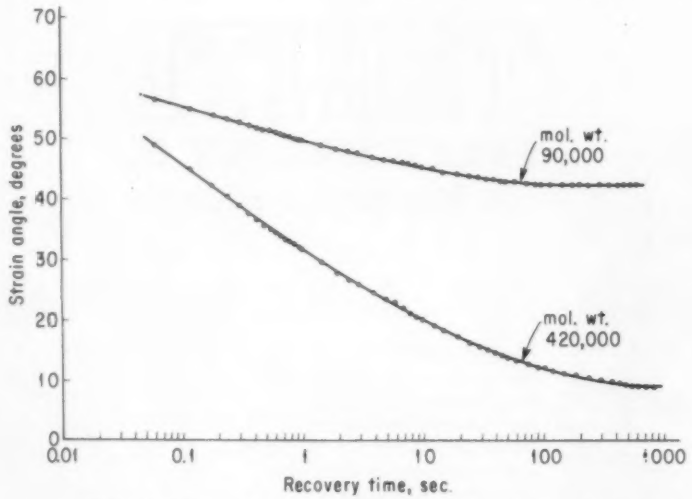

FIG. 10: Degree of strain in the melt as a function of the logarithm of recovery time for two Ziegler polyethylene melts of different weight average molecular weights. Both curves obtained at melt temperature of 350° F. using an initial strain of 59° and allowing instantaneous recovery to take place.

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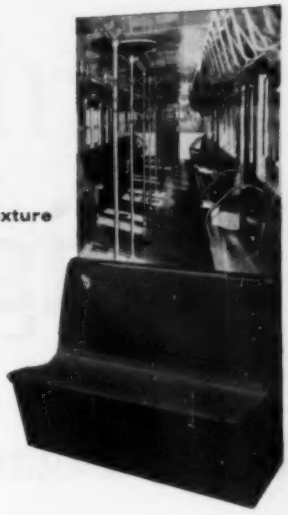

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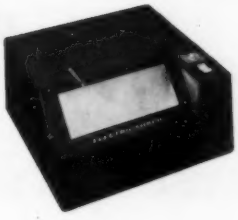

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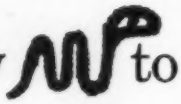
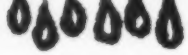
Using a binder especially formulated for this application, Johns-Manville Gun Roving has chemically-controlled chopping characteristics. It is static-free, chops cleanly, and lays down evenly without clumping. It conforms readily  to sharp radii and intricate shapes because it is soft, not stiff and wiry like other products of this type. It wets out  quickly with

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10 sec.$^{-1}$. These films show that, for this strain, total time of application is about ½ sec., which consists of a ⅜-sec. application period, followed by a constantly maintained strain period of ⅛-sec. at maximum strain before the applied straining force is removed.

In view of the relatively small rotations involved and of the strength of the melt of ferrous metal bond, the occurrence of slippage of the melt on the sampling area walls is assumed negligible. This assumption is substantiated by previous work (12).

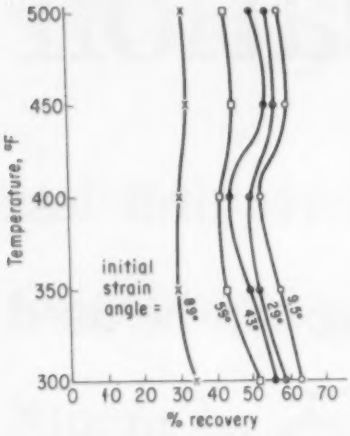


FIG. 11: Elastic recovery of a 3-M.I. Phillips-type linear polyethylene as a function of melt temperature using several levels of initial melt shear strain angle.

The inner (movable) member of the apparatus is supported by low-friction ball bearings. The inner sample area is insulated to maintain constant temperatures. The sample area temperature is recorded from a thermocouple located near the bottom of the sample well. Heater voltage is manually controlled by a variable transformer; operating temperature was easy to maintain to within ±2° F. over the 300 to 500° F. range. The inner chamber was purged with nitrogen, providing an inert atmosphere to minimize thermal or oxidative degradation.

The test specimen is in the form of a right cylindrical cup with a ¼-in. O. D., 3/16-in. I. D., and a height of 1⅛ inches. The cylindrical shear surfaces of the instrument are parallel and concentric to each other, and the length of the inner, rotating member is such that the 1/32-in. sample wall thickness is maintained between it and the stationary wall surface.

Sample preparation

Test specimens were injection molded on a 1-oz. vertical Watson-Stillman machine. The modified sample mold was a ¼- by 3-in. rod mold provided with a brass core to produce the necessary inner cup dimensions. The excess rod section of the molding is removed from the bottom of the cup to give a uniform sample 1⅛ in. long; slightly shorter than the depth of the sample well to allow for thermal expansion. Table I, p. 118, lists the molding conditions used to mold the different materials. Molding conditions for each sample were strictly maintained to prevent variable thermal histories. The specific materials tested and the properties are listed in Table II, p. 124.

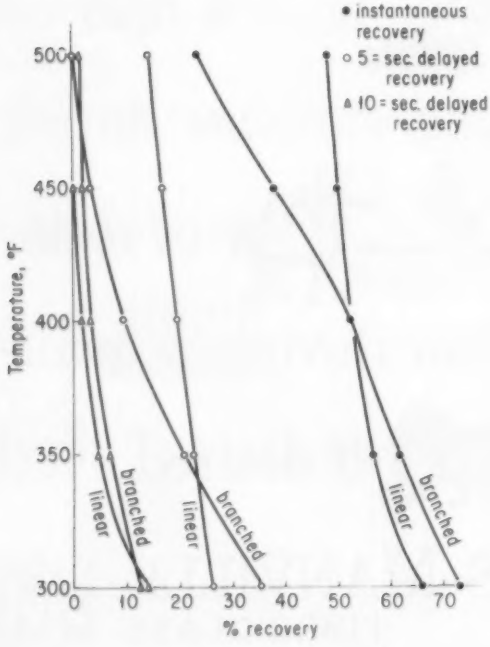


FIG. 12: Elastic recovery of linear and branched polyethylenes as a function of temperature, showing the effect of delaying the release of the external straining force (delayed recovery) on the total elastic recovery of the melt. Delaying the release of the external straining force allows relaxation to take place in the melt and reduces the elasticity of the melt. All curves obtained using an initial strain of 59°.

Operative procedure

After an initial warm-up period to reach the desired operating temperature, a molded sample specimen is slipped onto the small end of the center shaft. The upper assembly is then carefully realigned with the sample cavity and replaced into its prefixed position. Ten minutes were allowed to completely melt the sample and to reach temperature equilibrium. During this time, the sample area is continuously purged with nitrogen. After this 10-min. period, the center shaft is manually rotated by a rapid, steady motion by pushing the lever to its maximum preset stop position, thus applying the initial shear strain to the melt. The lever is then immediately released, removing the external driving force from the center shaft. The inner movable assembly is then permitted to recover freely until no observable motion is detected on the pointer scale over a 2-min. period. The final equilibrium position or angle of permanent strain is recorded and the amount of elastic recovery is expressed as percent recovery, based on maximum amount of initially applied strain.

In delayed strain recovery experiments, the same procedure is followed, except that the lever is held at the maximum travel position for a prescribed period of time before it is released. The data for the percent recovery vs. time curves were taken from 8-mm. movie films, which continuously recorded the motion of the deformation angle pointer with respect to the scale and the dial of a running stop watch as the test progressed. After each run, the instrument was cleaned thoroughly prior to the next run.

Figs. 4, 5, and 6, p. 121, summarize the recovery data using values of initial strain, **(To page 232)**

Unique function of SAIB aids plastics processors

A semi-solid at room temperature, SAIB has a molecular weight of 838. It is exceptionally light in color and unusually stable to ultraviolet light. SAIB exhibits outstanding hydrolysis and thermal stability. (Less than 0.1% is hydrolyzed after refluxing 96 hours with water. Heated to 175°C. for a period of 6 days, its color increases slowly to straw yellow, with no appreciable change occurring until after 24 hours of heat-aging.) SAIB is compatible with a wide variety of polymers, modifiers and plasticizers and is highly soluble in most common solvents. (A 90% solution of SAIB in ethyl alcohol has a viscosity of only 750 centipoises at 30°C.)

When used in conjunction with dimethyl phthalate and other common plasticizers, SAIB offers processors of cellulose acetate plastics the means of achieving

easier dry-blending
faster molding cycles
increased extrusion rates
improved physical properties

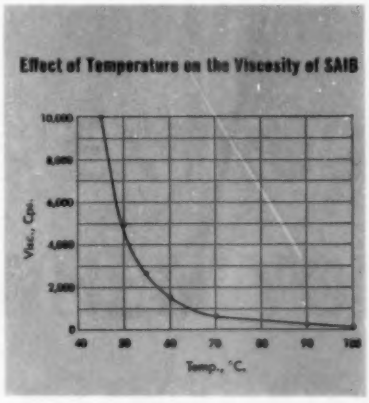
SAIB aids in dry-blending

SAIB deactivates the cold solvency characteristics of dimethyl phthalate and similarly-active plasticizers. By blending SAIB with the plasticizer before compounding, even distribution of the plasticizer throughout the cellulose acetate mix is readily accomplished, eliminating the problem of paste formation.

SAIB increases molding and extruding rates

The presence of SAIB in a plasticized cellulose acetate formulation permits faster, more uniform flow through extrusion and molding cylinders *without decreasing hardness or flexibility*.

As illustrated in the graph, SAIB has an extremely high temperature-viscosity index. Note that at 70°C., its viscosity is less than 1,000 centipoises. Below this temperature, however, a sudden increase occurs. At 50°C., its viscosity is approximately 4,500 centipoises. At room temperature, it becomes a semi-solid.



At molding or extrusion temperatures, SAIB aids in plasticization, while at room temperature it has the opposite effect, stiffening the plastic and increasing its surface hardness. This unique behavior of SAIB permits molding and extrusion conditions applicable to a material one or two flows softer than its hardness and rigidity at room temperature would indicate.

Similarly, in vacuum-forming, cellulose acetate sheeting formulated with a dimethyl phthalate-SAIB blend submits to deeper drawing before blushing occurs, again because of this unusual temperature-viscosity relationship.

SAIB improves physical properties

Modification of cellulose acetate formulations with SAIB increases hardness, rigidity and tensile strength, and decreases weight loss on accelerated aging.

Note that this improvement in physical properties achieved at practical flow temperatures is due to the behavior of SAIB and not to a decrease in plasticizer content. Dimethyl phthalate-SAIB formulations exhibiting physical characteristics in the range of H 5 or H 6 have been extruded without difficulty.

Hot melts, peelable coatings

With its excellent permanence, compatibility and stability characteristics, SAIB can be used to advantage in hot melt and peelable plastic formulations.

Tough, flexible melt coatings can be made containing up to 70% SAIB. One of their outstanding features is a complete absence of fuming at melt temperatures. Operating temperatures are lower, too. The usual application temperature for conventional butyrate hot melts is 350°F. With high SAIB modification, optimum operating temperature is only 275°F.

In ethyl cellulose compositions, SAIB acts as a solubilizer for mineral oil, reducing exudation of the oil from the film and enabling the formulator to use increased amounts of oil.

In peelable coatings, SAIB improves resistance to exudation, thus maintaining flexibility.

SAIB is so unusual—acting as a plasticizer under certain conditions, and as resin extender under others—you will want to try it in your own formulations, under your own processing conditions. You can get a sample of SAIB, as well as a technical report on its physical properties and performance, by writing to your nearest Eastman sales office or to EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENN.

SAIB

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Eastman CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company

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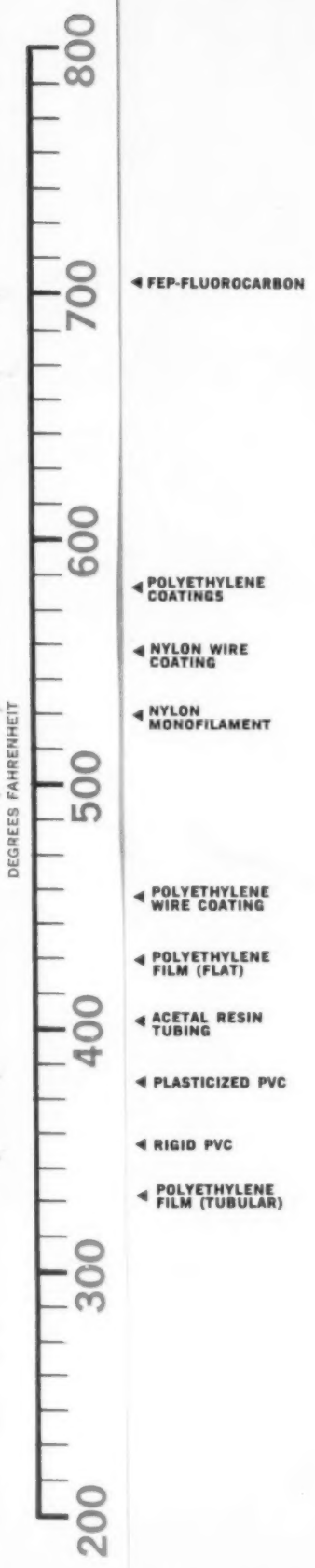

NO ONE CAN BEAT YOUR EXTRUSION COST WHEN YOU'RE RUNNING A DAVIS-STANDARD THERMATIC EXTRUDER

◀ Learn how you control extrusion profits when Davis-Standard controls temperature

TEMPERATURE CONTROL THE KEY TO EXTRUSION PROFITS

As new thermoplastic compounds become available, processors find it increasingly important to select extruders that will operate successfully at the temperature level required of each resin. The **range** of operating temperatures has increased tremendously.

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Profits are often made or lost in the truder barrel. Too rapid "shock" cooling cause erratic operation of the extrude damage to the barrel or screw. Une erratic cooling can result in output va tions that in turn cause product defects. stricted cooling capacity can slow pro tion, particularly with the tougher resin harried, overworked operator can let d on the job.

But you have none of these worries Davis-Standard's Thermatic tempera control system—the only system avail today that provides uniform heat and pre control.

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Moreover, with finned external cylinder surfaces, you have maximum heat transfer area in minimum space. Heat is dissipated smoothly from its **source,** not thro remotely located external cooling media

Thermatic cooling relies on **air** — natu ideal cooling medium — for the smoot most stable, most precise method of dissipation. An important by-product of ural air cooling is low maintenance c There are no water tubes or small diam jets to clog or corrode. There is no circ ing oil. Naturally, your equipment longer.

HIGH SPEED PRODUCTION POSSIBLE ONLY WITH AMPLE COOLING CA

STABLE OPERATING TEMPERATURES. Thermatic air cooling eliminates sawtooth "cycling effect" of heat-off-cool systems. With one setting, it provides the correct perature for **any** compound. Operators concentrate on production, not temperature trol. Uniform heat dissipation avoids "thermal shock", prevents compound degrada or machine distortion.

RAPID COOL-OFF. Thermatic extruders cool quickly, evenly. Clean-up or screw change takes less time, lets you run another compound in short order.

NO MATERIAL LIMITATIONS. You run any thermoplastic resin with precise tempera control, no matter what operating temperatures are required.

HOW THERMATIC COOLING WORKS

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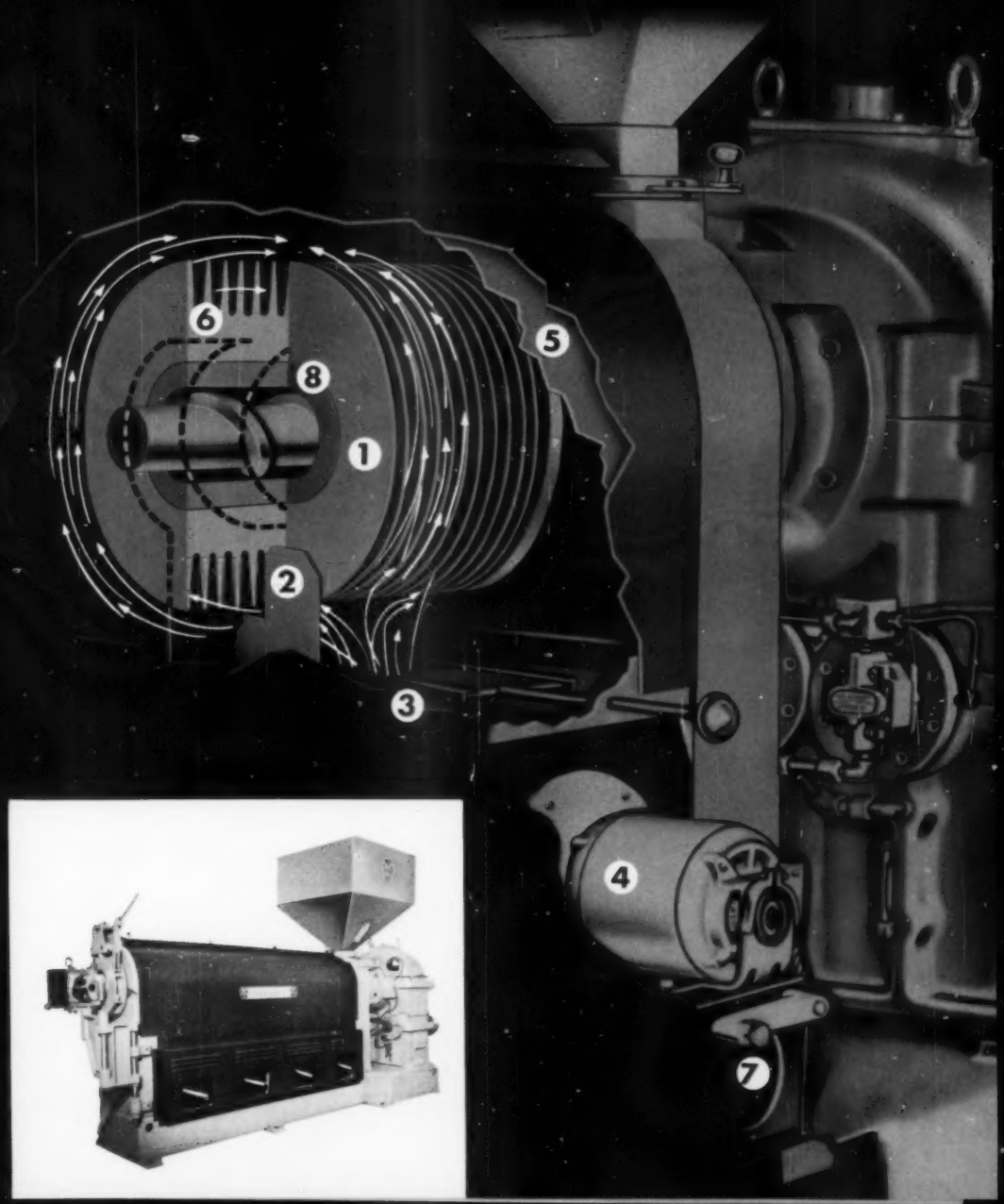
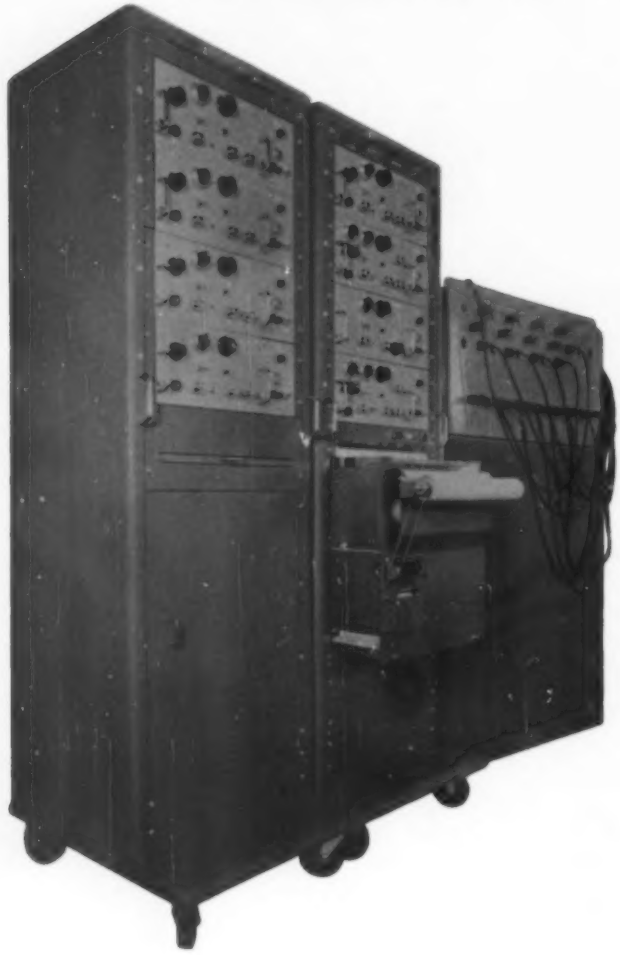
1. Two heavy-walled aluminum finned half-cylinders in each heat zone provide large radiating area in minimum space, dissipate heat fast.
2. Zone divider plate assures adjustable, accurate temperature control in each heat zone.
3. Dampers give high temperature "oven effect" operation, speed warm-up.
4. High capacity blower produces more than adequate air flow for proper cooling of all compounds, even stubborn resins that tend to build frictional heat.
5. Patented inner liner directs air flow around fins for even cooling around entire circumference of barrel, resulting in even heat dissipation.
6. Tubular cast-in resistance heating elements provide extremely long life with complete safety regardless of voltage. Serpentine shaped for uniform heating.
7. Intake damper provides infinite gradients of air intake for either natural draft or forced draft cooling.
8. Xaloy lined cylinder barrel.



NO ONE CAN BEAT YOUR EXTRUSION COST WHEN YOU'RE HELPED BY THE INDUSTRY'S MOST COMPLETELY INSTRUMENTED LABORATORY



Can you run the new compounds with your present equipment? What about pipe, profiles, other shapes? What extrusion screw speed and design gives optimum quality and output on rigid PVC pipe?

Tough questions? Yes—but not too tough for the Davis-Standard laboratory. Here you find the essential skills and equipment needed to answer questions that have a real bearing on extrusion profits.

Experienced engineers and technicians actually set up and test run sample jobs on the most highly instrumented, production-sized extruder available anywhere. Fact is, many leading resin producers come to Mystic to test the extrudability of their new compounds.

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These inputs are then recorded continuously on Sanborn electronic equipment for analysis by Davis-Standard research people.

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Davis-Standard offers a complete line of extruders from 1½" to 8" in L/D ratios from 10:1 to 26:1 — and accessory equipment — for blown film, sheet, blow molding, monofilament and multifilament, PVC pipe, wire and cable insulating, and compounding. Experienced sales engineers are ready to discuss your extrusion problems. Write for complete information.

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An editor's-eye view of . . .

25 years of progress in plastics

By Gordon M. Kline

Technical Editor

This year marks the completion of the 25th year of publication of the Technical Section of MODERN PLASTICS. This period has been marked by amazing technological developments in materials, processing methods, and scope of applications of plastics, and by expansion of the industry's productivity almost 50-fold from approximately 125 million lb. in 1935 to over six billion lb. in 1960. I have been asked to recapitulate some of the objectives, problems, and significant factors involved in editing this Section during this dynamic era.

It may come as a surprise to many of our readers that 25 years ago it was necessary to exhort (see MPl, Dec. 1936, p. 37, and Mar. 1937, p. 43) the industry's executives to release for publication technical papers describing the results of research in their laboratories. But the statistics show that in the first three years (June 1936 through May 1939) of the Technical Section, only one-third of the articles came from industrial laboratories. That this problem was not unique to us is evident from the following statement in the 1936 Annual Survey of American Chemistry: "The actual progress in the chemistry of synthetic plastics has been reflected to a much greater extent in the patent literature than in any of the scientific journals." Fortunately, awareness of the importance of publishing technical data to aid in developing new markets for plastics grew sufficiently to reverse this situation by 1940.

The statistics on the sources of papers in the Technical Section during the past quarter of a century indicate that approximately 50% came from industrial laboratories. The predicted "growth and enhancement of prestige" that would accompany a liberal policy of publication is evident from the fact that the list of consistent contributors over the years to the Technical Section is definitely "blue chip:" American Cyanamid, Bell Telephone, Du Pont, **(To page 242)**

*Reg. U. S. Pat. Off.

Gordon M. Kline, technical editor of MODERN PLASTICS since 1936, was born in Trenton, N. J., on Feb. 9, 1903. He received his A.B. degree from Colgate Univ. in 1925, his M.A. from George Washington Univ. in 1926, and his Ph.D. from the University of Maryland in 1934. His professional career includes such posts and honors as: research chemist, N. Y. State Dept. Health, 1926-27; research chemist, Picatinny Arsenal, 1928-29; chemist, physical science administrator, National Bureau of Standards, Washington, 1929-, chief, Organic Plastics Section, 1935-51, chief, Organic and Fibrous Materials Division, 1951-; editorial director, *Modern Plastics Encyclopedia*, 1936-1959; technical investigator with U. S. Army, ETO, 1945. Chairman of annual meetings of Technical Committee 61 on Plastics of International Standardization Organization in New York 1951; Turin, Italy, 1952; Stockholm, Sweden, 1953; Brighton, England, 1954; Paris, France, 1955; The Hague, Netherlands, 1956; Burgenstock, Switzerland, 1957; Washington, 1958. Secretary, Division of Plastics and High Polymers, International Union of Pure and Applied Chemistry, since 1951. Member, Materials Advisory Board of the National Academy of Sciences—National Research Council. Member, Princeton Plastics Advisory Council. Director, American Society for Testing & Materials. Recipient: honor award of American Institute of Chemists, Washington Section, 1952; exceptional service gold medal, Dept. of Commerce, 1953; ASTM Award of Merit, 1954. Member of American Society for Testing & Materials, American Chemical Society, American Institute of Chemists, American Society of Mechanical Engineers, Society of Plastics Engineers, Society of Plastics Industry, Washington Academy of Sciences, Phi Beta Kappa, Sigma Xi. Editor: Analytical Chemistry of Polymers, Part I, 1959; Parts II and III, in press. Member of Advisory Board of *Journal of Polymer Science*. Contributor to *Encyclopedia Americana, Medical Physics*, and *Encyclopedia of Chemical Technology*. He has authored numerous articles in many scientific journals.

Thermal properties of reinforced plastics

By Paul T. Howse Jr.* and C. D. Pears*

Specific heat, thermal expansion, and thermal conductivity were determined for 12 different resin-reinforcement combinations and one foam core over the temperature range —50 to 700° F. Specific heat is about constant with temperature and seems to be influenced more by the reinforcement materials than any other single parameter, probably because the heat capacity of the different reinforcements varied more than that of the different resins. The glass-reinforced materials had the lowest specific heats, the asbestos-reinforced materials were next, and the one nylon-reinforced material had the highest value. Actually, the specific heat appears to be the weighted average of the basic resin and reinforcement after make-up and postcure.

The expansion coefficient was influenced primarily by both the over-all composition and the orientation of the reinforcing fibers. The coefficient progressed from a minimum when determined at 0° to the major axis of the fibers, to a maximum when determined at 90° and parallel to the major axis of the fibers. The expansion of a material normal to the panel has the same characteristics, but of greater magnitude, as that of the expansion parallel to the panel, indicating that resin controls the character and the fiber orientation the magnitude. The expansion properties of a material may be completely altered after exposure to a critical temperature range.

The thermal conductivity of a material increases with temperature to a critical temperature and is influenced by production methods and reinforcement orientation as well as composition. Conductivity determined edgewise to a panel was influenced more by the reinforcement than by the resin. In the case of panels with glass reinforcement, the conductivity was considerably higher edgewise than normal to the panel. The conductivity normal to a panel was influenced more by the resin than the reinforcement.

The constantly changing requirements for plastics in missile and space applications have created a growing list of new materials as well as variations and modifications of old ones. Since the design of components utilizing these materials requires knowledge of their physical properties, there has been renewed interest in establishing property data for those materials and for showing how the various compositions of these materials influence the properties.

Thermal properties have taken on prime importance in such applications as rocket nozzles, nose cones, and other applications where thermal insulation is one of the major design considerations. Because of differences in composition and method of manufacture, there is considerable variation in the thermal properties of panels made with similar resins and reinforcements. For this reason, thermal properties must be determined on the particular material to obtain precise data. However, the general ranges of values for various material classes do permit preliminary design.

This article presents data on specific heat, thermal expansion, and thermal conductivity for eight laminates, four molded panels, and one foam core, representative of classes of materials of particular interest. In addition, measurements were made with several different reinforcement orientations on three of the laminates. Table I, p. 143, gives the physical properties as reported by the manufacturers of the various materials, or which were determined at Southern Research Institute. (In Table I, see also reference to Fig. 1).

*Asst. Engr. and Head, respectively, Analysis and Measurements Section, Southern Research Institute, Birmingham, Ala.

This research was supported in part by the U. S. Air Force under Contract No. AF 33 (616)-6073 monitored by the Materials Laboratory, Wright Air Development Div., Wright-Patterson Air Force Base, Ohio.

Specific heat

Specific heat determinations were made by means of a drop-type adiabatic calorimeter consisting of an inner cup to receive the specimen, a guard with heating and cooling devices to maintain adiabatic conditions, and temperature sensing devices. The specimen was brought to temperature by means of a tubular furnace or a cold box. A simplified sketch of the equipment is shown in Fig. 2, p. 142. The calibration of the apparatus was confirmed with copper and sapphire specimens for which the specific heat values have been well established.

The specific heats ranged from 0.25 B.t.u./lb. °F. for SRI 5 (a silicone-glass) to 0.47 B.t.u./lb. °F. for SRI 9 (a phenolic-nylon), but most of the materials exhibited a value between 0.25 and 0.32 B.t.u./lb. °F. A complete presentation of

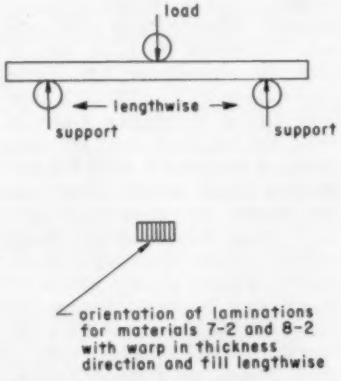
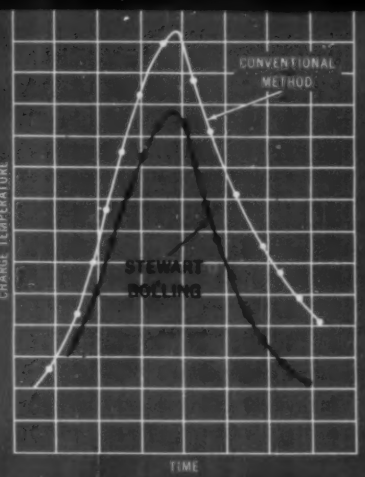

load
lengthwise
support
support
orientation of laminations for materials 7-2 and 8-2 with warp in thickness direction and fill lengthwise

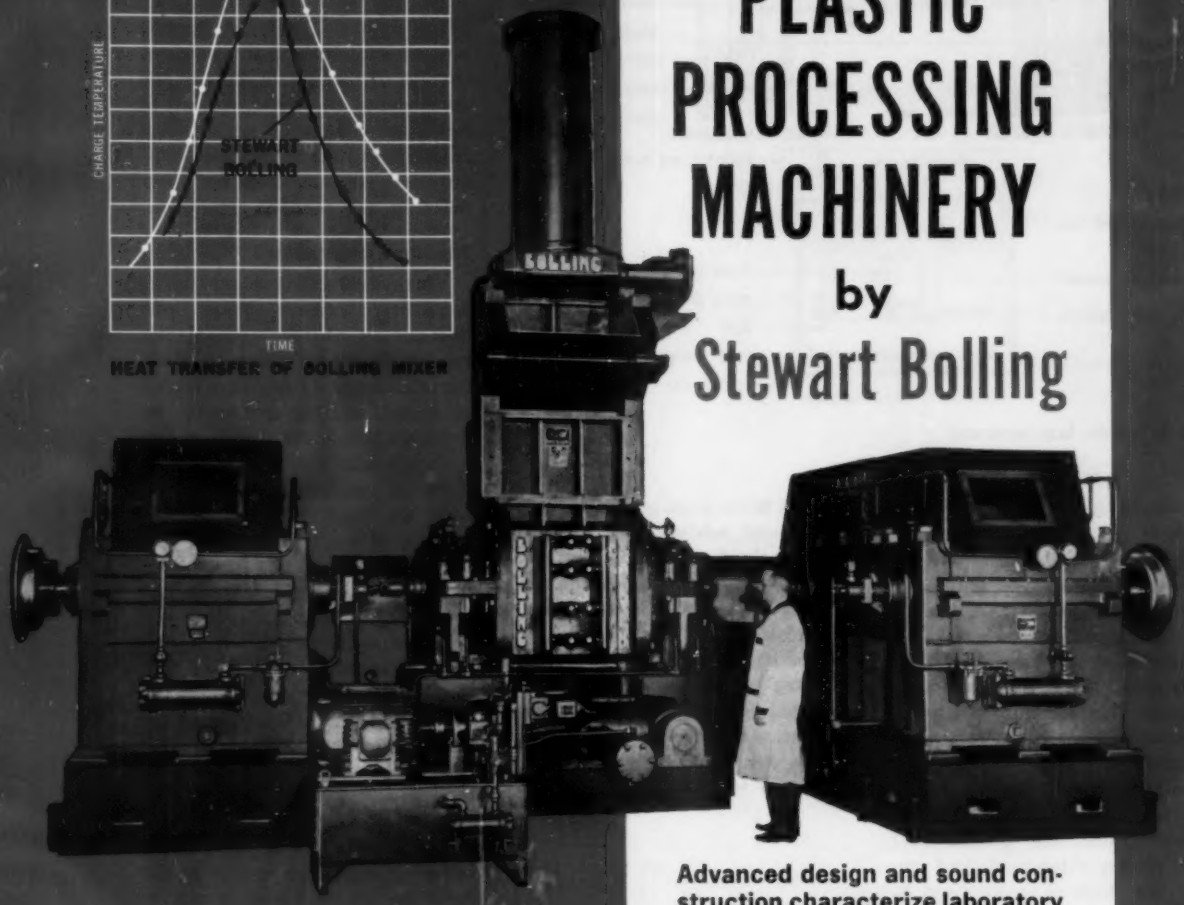
FIG. 1: Orientation of materials for flexural strength determination.



HEAT TRANSFER OF BOLLING MIXER

PLASTIC PROCESSING MACHINERY

by Stewart Bolling



Stewart Bolling Model 12-M plastic intensive mixer with 2000 h.p. dual drive, featuring hinged drop door and high heat transfer chamber.

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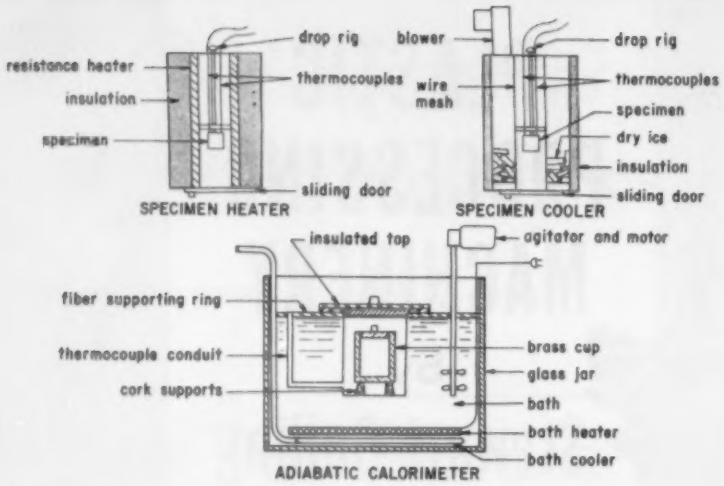

FIG. 2: Specific heat apparatus.

the specific heat values is given in Table II, p. 149.

Upon comparing the physical make-up and properties of the materials, a correlation between the specific heats and the types of reinforcement was suggested. Generally speaking, the glass-reinforced materials had the lowest specific heats, while the asbestos-reinforced materials were next, with the one nylon-reinforced material exhibiting the highest value. It is not surprising that the specific heat value for the nylon-reinforced material was high in comparison to the glass-reinforced materials, because nylon itself has a specific heat that is rated at about twice that of glass.

No correlation could be established between density, cure, or percent resin and the specific heat. The panels did not cover a sufficient range of these variables to permit accurate conclusions. Oglesby[1] reported that the specific heat increased with resin content in those cases in which the resin had a higher value than the reinforcement. He also reported that with other properties equal, the specific heat increased proceeding from the silicones to the phenolics to the polyesters. From Table II, it appears that the specific heat of the epoxies falls in line with those of the phenolics.

Essentially, the specific heat of the panels was constant over the full temperature range up to about 700° F. Silica glass, quartz, vitreous silica, and asbestos are reported to have about a 0 to 30% increase in specific heat from room temperature to about 700° F. Apparently, the resins must exhibit a slightly decreasing specific heat with increasing temperature. Oglesby also reported essentially constant specific heats for phenolic and silicone panels over the temperature range from 200 to 500° F. From 100 to 200° F., he indicated lower values. From the data available, it appears probable that the specific heat of a laminate is the weighted average of the specific heat of the components. Of course, for this to be so there must be no chemical reactions and the components must be considered as they are after make-up and postcure treatments.

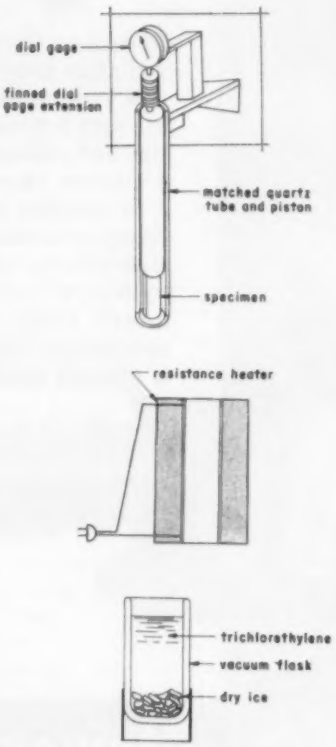

FIG. 3: Sketches of thermal expansion apparatus.

Thermal expansion

Thermal expansion measurements were made utilizing quartz tube dilatometers of the National Bureau of Standards design in which the specimen and tubes were heated or cooled and the motion of the specimen noted. As shown in Fig. 3, below left, the apparatus consisted of concentric quartz tubes with the inner tube transmitting motions of the specimen to a dial gage. For temperatures above room temperature, the dilatometer was heated by a resistance heater. Cold temperatures were obtained by enclosing the tubes in a Dewar flask filled with dry ice and trichloroethylene. The accuracy of the apparatus was checked with graphite and nickel specimens, materials with low and relatively high expansion coefficients, respectively.

Figure 4, p. 144, shows the curves of expansion parallel to the panel for all the materials run in this direction. Most of the materials had a reasonably constant expansion from −100 to 200° F. After passing 200° F., however, the curves exhibited very little similarity. SRI 1-1, 7-1, and 11 (all with continuous reinforcements but different resins) expanded until they reached a maximum at some temperature and then began to contract. SRI 1-1 and 7-1 (an epoxy and a phenolic with a relatively light cure) reached the maximum expansion at a fairly low temperature; SRI 11 (a phenolic with a hard cure) continued to expand to around 600° F. Perhaps the more severe cure extends the linear portion of the expansion curve to higher temperatures. SRI 2 (chopped glass-phenolic) had a plateau preceding its maximum expansion and, after reaching its maximum and declining, began to expand again. A relation between inflections and discontinuous reinforcements is suggested. SRI 4 and 6 (also phenolics with a discontinuous reinforce-

[1] "Thermal properties of reinforced plastics," by S. Oglesby Jr., published in Review of Structural Plastics, Sept. 10-11, 1958, WADC TR 58-555, cf. Also, "Thermal properties of laminates," by F. R. O'Brien, S. Oglesby Jr., and F. C. Covington, Modern Plastics 33, 158 (Aug. 1956).

Table I: Materials investigated

SRI No.	Type	Reinforcement	Resin	No. of plies	Thickness, in.	Amount of resin, %	Finish	Catalyst	Fabrication and curing	Density, lb./ft.³	Barcol hardness on panel face	Flexural strength at room temp., p.s.i.
1-1	Unidirectional laminate	60N roving	Epoxy 3MXP-175	20	0.125	30 ±1.5	Garan	3MXP-175	Press temp. 275-280° F. Total time in press 40 min. Pressure on panel[a] 90-95 p.s.i. Postcure temp. 225° F. Time in postcure 16 hr.	114.9	62	129,000
1-2	Isotropic laminate	60N roving	Epoxy 3MXP-175	21	0.122	30 ±1.5	Garan	3MXP-175	Press temp. 265-270° F. Total time in press 40 min. Pressure on panel[a] 90 p.s.i. Postcure temp. 225° F. Time in postcure 16 hr.	114.9	60	74,000
2	Molded panel	181 chopped glass	Phenolic CTL-91 LD	Molded	0.281	35 ±5	A-1100	"B" stage phenolic	1 hr. at 275° F. Postcure 24 hr. at 275° F.	114.2	60	15,210
3	Foam core	—	Silicone foam R-7002	Foam	0.638	—	—	—	1 hr. at 390° F. 1 hr. at 435° F. 24-48 hr. at 480° F. Cooling cycle: 1 hr. at 435° F. 1 hr. at 390° F. 1 hr. at 150° F.[b]	11.60	Compressive strength = 200 p.s.i.	
4	Molded panel	Glass roving No. F846	Phenolic R181	Molded	0.230	48 = 53	—	C-205	Curing in hydraulic press at 2000 p.s.i. Cured for 20 min. at 320° F.	107.9	60	20,000
5	Molded panel	Chopped glass 1B603; ¼" chopped squares	Silicone 4P020, F130R; DC-2106	Molded	0.273	35 ±3	—	Dow Corning XY-15	16 hr. at 200° F. 2 hr. at 260° F. 2 hr. at 300° F. 2 hr. at 350° F. 2 hr. at 400° F. 2 hr. at 440° F. 12 hr. at 482° F. Cooled to 200° before removing from oven.	106 to 109.7	53	41,800
6	Laminate, random reinforcement	¾" x ¾" squares of 1201V cloth	Phenolic SC-1008	Molded	0.132	30 = 35	None	None	Curing: 2 hr. at 300° F.	90.0	54	5,000
7-1	Laminar construction, parallel layup	Refrasil, 184 weave	Phenolic SC-1008	6	0.126	30 = 35	None	None	Curing: 2 hr. at 300° F.	90.0	60	25,000
7-2	Edgewise layup with thickness in warp direction	Refrasil, 184 weave	Phenolic SC-1008	50/in.	0.125	30 = 35	None	None	Curing: 1 hr. at 200° F. 1 hr. at 250° F. 2 hr. at 300° F.	90.0	33	21,020[c] 3,300[d]
8-1	Laminar construction, regular layup, parallel	181 "E" glass fabric	Phenolic CTL 37-9X	14	0.132	25.7	A-1100	None	Molding cycle: Type of molding — press. Part pressure — 100 p.s.i. Curing — ½ hr. at 280-290° F. Postcure cycle: 4 days at 250° F.	116.5	78	Warp - 24,000 Fill - 13,200
8-2	Edgewise layup with thickness in warp direction	181 "E" glass fabric	Phenolic CTL 37-9X	91/in.	0.699	31.2	A-1100	None	Molding cycle: Type of molding — press. Part pressure — 100 p.s.i. Curing — 4 hr. at 280-290° F. Postcure cycle: 4 days at 250° F.	111.0	64	41,900
8-3	Edgewise layup with thickness at 45° to warp direction	181 "E" glass fabric	Phenolic CTL 37-9X	—	0.708	24.3	A-1100	None	Molding cycle: Type of molding — augmented bag. Part pressure — 100 p.s.i. Curing — 4 hr. at 280-290° F. Postcure cycle: 4 days at 250° F.	111.7	62	See 8-1 and 8-2
9	Chopped fabric construction	SN-19 nylon, heat set and scoured	Phenolic CTL-91 LD	—	0.265	42	—	—	Molding cycle: 1 hr. at 275° F.	72.0	16	10,750
10	Laminate	40 RPD asbestos	Silicone DC-2106	37	0.121	—	—	—	Loaded at 330° F. 20 sec. required for loading, 20 sec. for closing press. Full pressure applied and bumped after 20 sec. Cured 1½ hr. at 330° F. and 850 p.s.i. Removed hot from press.	113.6	61	Warp - 27,200 Fill - 19,600
11	Laminate	Glass, type YM-31A weave, style 181	Phenolic CTL-91 LD	—	0.116	38-40 in prepreg. 31 in product	A-1100	—	Pressure — 345 p.s.i. Press cure — 20 min. at 300°F. Postcure — 24 hr. at 300°F. 24 hr. at 350° F. 24 hr. at 400°F.	131.0	86	Warp - 59,300 Fill - 54,800
12	Laminate	Glass, type YM-31A weave, style 181	Epon 1031 epoxy	—	0.110	38-40 in prepreg. 22 in product	Volan A	CL	Pressure — 245 p.s.i. Press cure — 30 min. at 340° F. Postcure — 24 hr. at 300° F.	137.5	76	Warp - 84,000 Fill - 80,100
13	Mat	Asbestos R/M, style 42 RPD	Phenolic R/M, high heat-resistant	40	0.147	25-30	—	None	No postcure.	117.0	74	Warp - 47,600 Fill - 36,400

[a]Cured to 0.125-in. stops. [b]From Dow Corning literature. [c]Fill lengthwise (see Fig. 1, p. 140). [d]Fill across length (see Fig. 1.)

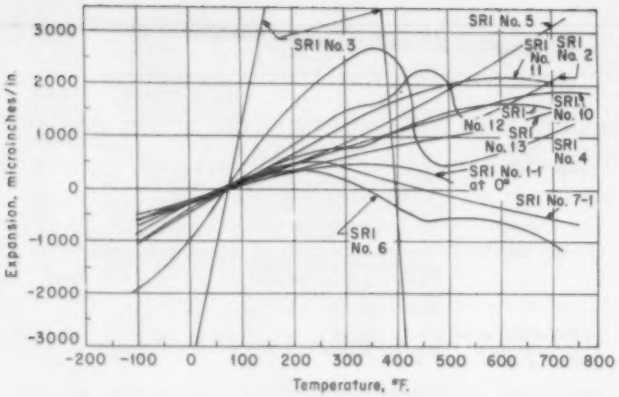

FIG. 4: Thermal expansion parallel to panel for all materials.

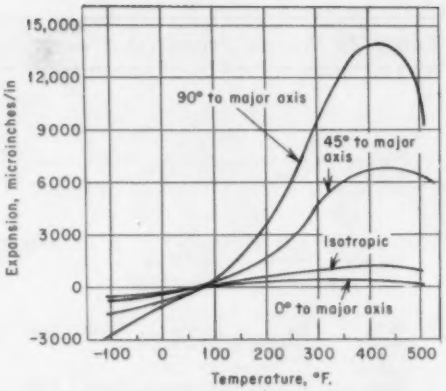

FIG. 5: Influence of reinforcement orientation on expansion of 60N roving-epoxy panels.

ment), although not exhibiting this plateau before the maximum expansion was reached, did show an increasing expansion after a prior inflection, again relating inflections and discontinuous reinforcements. SRI 5 and 13 (silicones with a hard and light cure, respectively) had reasonably constant expansion to 700° F. SRI 10 (a silicone-asbestos with a light cure) had a linear expansion to about 600° F. This linear expansion is typical of materials with silicone resins, probably because this resin remains more stable at higher temperatures regardless of cure, even though the reinforcements included chopped glass and asbestos. Perhaps the inflections can be reduced by both continuous reinforcements and silicone resins.

The orientation of the reinforcement has a major influence on the thermal expansion that occurs in a plastic-filled laminate. An interesting comparison of the same material expanding differently in different orientations is shown in Fig. 5, above. The curves indicate an increase in expansion for the same material from a minimum, oriented at 0° to the major axis of the fibers and parallel to the plane of the reinforcement, to a maximum at 90° to the major axis of the fibers and parallel to the plane of reinforcement. The curve for the expansion of the isotropic laminate is also included for comparison. The expansion of the isotropic laminate was most closely related to the expansion along the major axis. This big difference in expansion rates for various reinforcement configurations is an indication of the importance of the orientation of plastic laminates in design considerations. However, this material had a roving reinforcement, which probably caused a greater difference in expansion at different orientations than would have been exhibited for a woven reinforcement.

An interesting comparison that shows, in part, the influence that the resin and cure have on the over-all expansion of a plastic laminate parallel to layup is shown in Fig. 6, below left. The curves in this

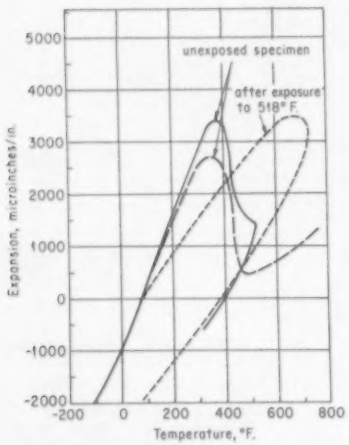

FIG. 6: Influence of resin cure on expansion of a glass roving-phenolic panel.

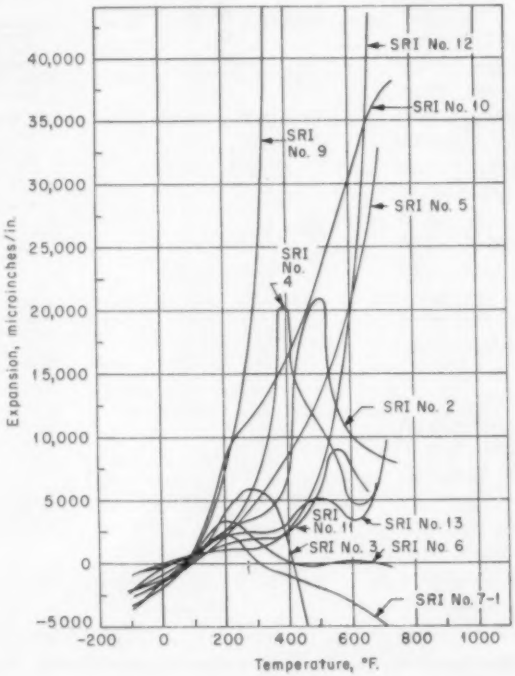

FIG. 7: Thermal expansion normal to the panel for all of the materials.

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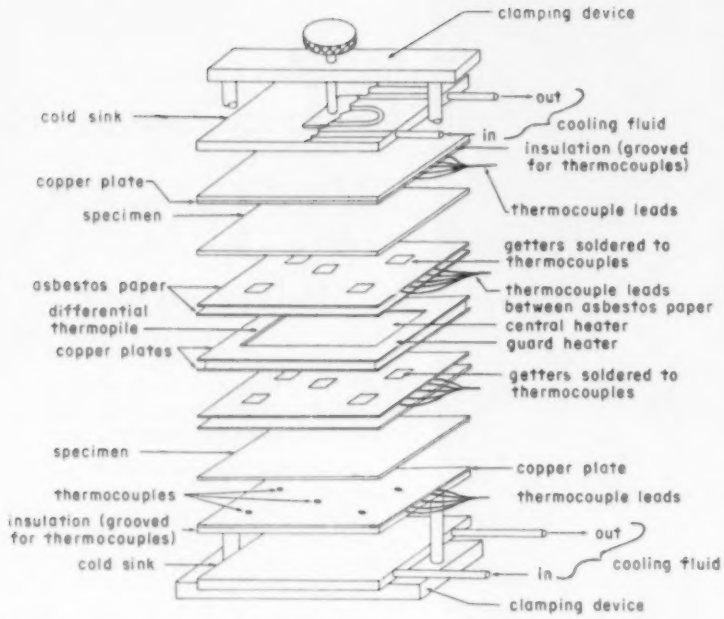


FIG. 8: Thermal conductivity apparatus.

figure were produced by running one specimen of SRI 4 (a phenolic glass) to 518° F., allowing it to cool, and then re-exposing it to 735° F.; a second specimen was then run to 774° F. on its first exposure. The results of the first runs of each specimen show a similar characteristic that is inherent in many laminates with either continuous or discontinuous reinforcements and is probably caused by the resin; the material expands to some point, levels off, and then contracts to a point where it again levels off and begins to re-expand. This characteristic inflection is probably the result of additional curing of the resin at the elevated temperature. When the first specimen was run a second time, there was a decrease in the expansion coefficient and the characteristic hill and valley inflections were replaced by a smooth curve to the maximum expansion. This indicates that the chemical change in the resin was permanent and produced a permanent change in subsequent expansion properties.

Figure 7, p. 144, is a composite of all of the curves produced by the expansion of the materials when evaluated for motions normal to the panel. The expansion normal to the panel usually is greater but has the same characteristics that are found in the parallel direction for the same materials. This increase in expansion normal to the panel can probably be attributed to several factors. There is undoubtedly considerable slippage between the layers of the reinforcement. As this slippage occurs, the layers can buckle and add to the thermal motions of the expansion of the base materials. The resin has a greater expansion coefficient than most of the reinforcements and, being unconstrained by a reinforcement, is free to expand more.

Figures 4 and 7 provide an indication of the difficulty in presenting precise expansion data over an extended temperature range. The thermal expansion for reinforced plastics is not smooth and continuous, as it is for most metals. The motions are influenced by such things as cures, postcures, resins, reinforcements, orientations, and other factors. The complete history of the reinforced plastic determines its thermal expansion pattern.

Thermal conductivity

Thermal conductivity measurements were made with a guarded hot plate, which was a slight modification of the standard ASTM C177-45 design. The heat for the apparatus was supplied by a central heater plate surrounded by a guard heater. The guard ring was maintained at the same temperature as the central heater so that all of the heat flow from the central heater was normal to the test surfaces. The temperature difference between the guard and central sections was maintained at essentially zero by a differential thermopile located across the two. The complete assembly is shown in Fig. 8, above, with the specimens sandwiched between the central heater and cold sinks on either end. Thermocouples were located at the specimen faces to measure their temperatures. The assembly was arranged to operate with the specimen placed in the apparatus horizontally, with the edges insulated by glass batting.

Conductivity curves for all materials are shown in Fig. 9, below. And points were also obtained on

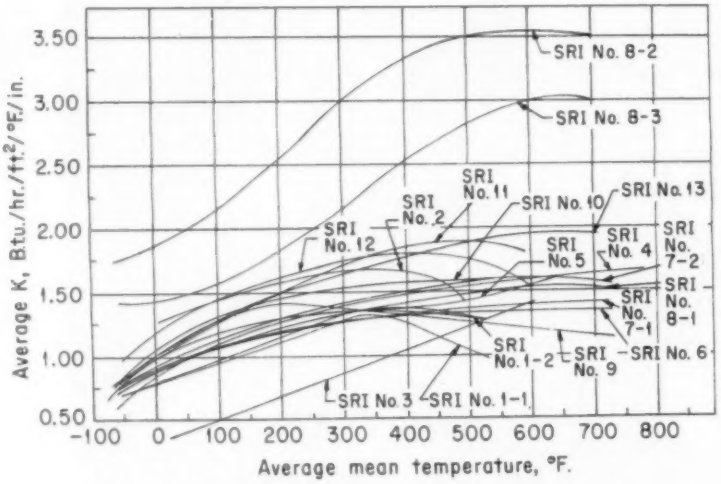
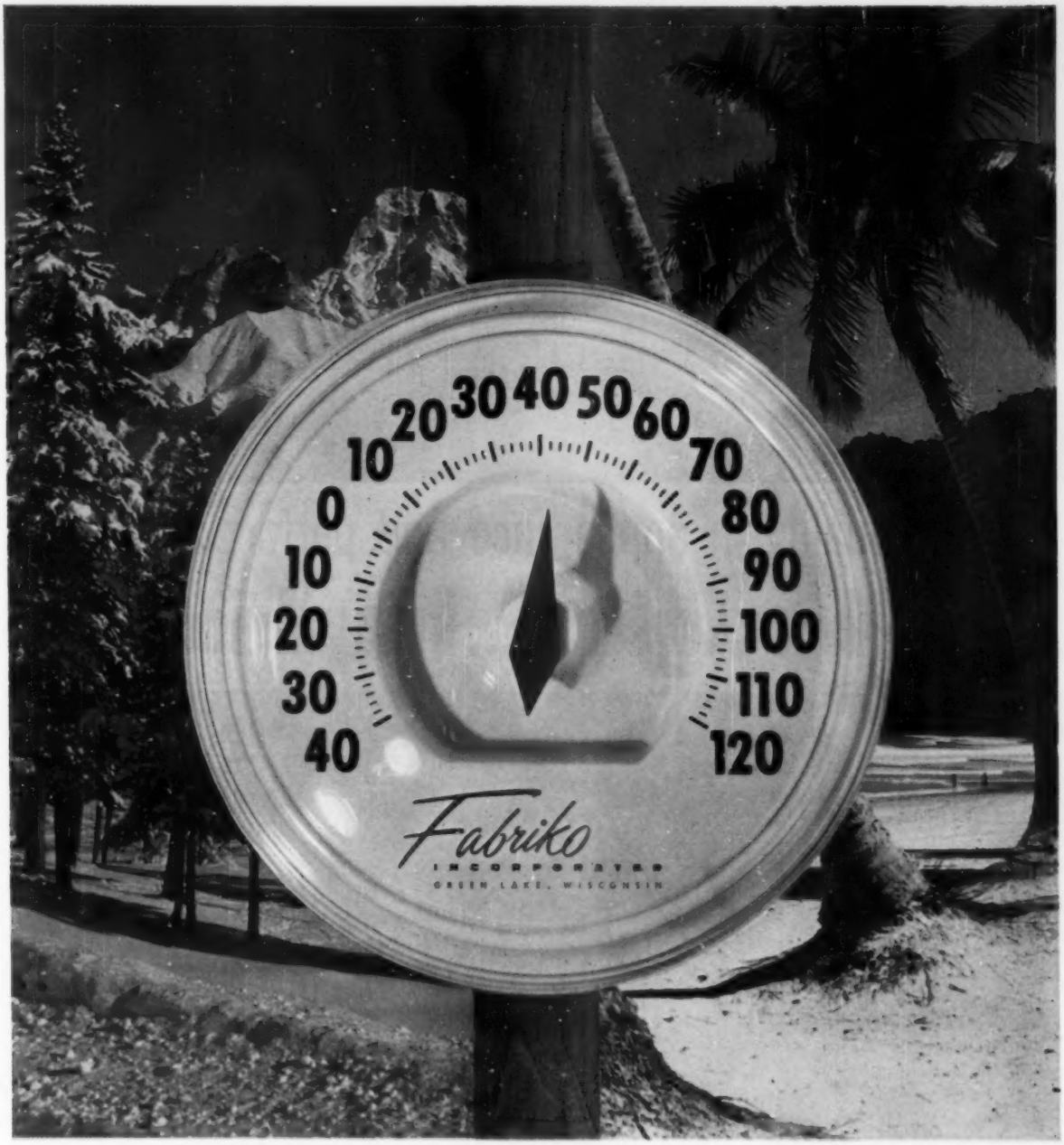


FIG. 9: Thermal conductivity of several reinforced plastics.



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these materials during the cooling cycle after the material had been to the top temperature exposure. For the sake of clarity, these points are not included, but in all cases, a reduced conductivity of 10 to 20% was indicated. This could be the result of a nonreversible cure at the higher temperatures or simply the loss of resin. The condition of the panels following exposure to the high temperatures is reported in Table III, p. 153.

The conductivity of most of the materials fell within a fairly narrow range, with some of the materials indicating an increasing conductivity to relatively high temperatures, whereas the conductivity of other panels began decreasing at fairly moderate temperatures. Several factors appear to cause a material to maintain an increasing conductivity throughout most of the temperature range. The first and most apparent factor is the resin type. Silicones are stable to the higher temperatures and, therefore, undergo very little change in the base materials. Some of the high temperature phenolics are also very stable and indicate a continuously increasing conductivity. Second, extended postcures apparently contribute to a stable material with minimum high temperature inflections. The third factor is molding pressure. High molding pressures seem to contribute to a uniformly increasing conductivity.

The conductivity of SRI 8, a phenolic-glass with a regular layup, increased as the orientation of the heat flow direction to the fabric was varied from normal to the panel, to 45° to normal, to 90° to normal or edgewise to the panel (Fig. 10, above). This material also had an unusual S-shaped character when run edgewise and at 45° to normal. This shape has not been exhibited before by glass-reinforced laminates. Some glass does have a characteristic conductivity curve that increases sharply with temperature. It is possible that this characteristic of glass is controlling in planes other than normal in which the reinforcement forms a continuous path for the heat flow. SRI 7-2 was also oriented for edgewise flow and had a higher conductivity than the normal flow thru the similar panel, SRI 7-1. The influence of orienta- **(To page 153)**

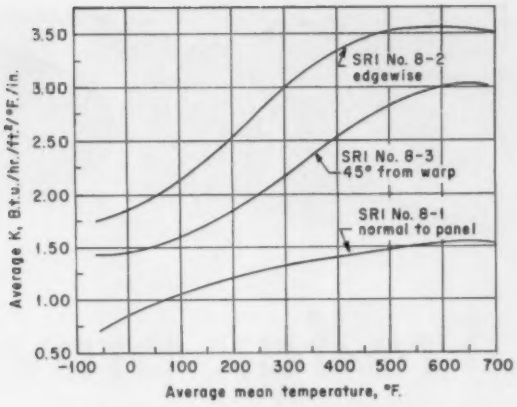

FIG. 10: Influence of fabric orientation on conductivity (CTL 37-9X phenolic-glass).

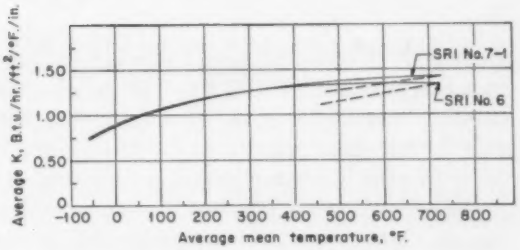

FIG. 11: A comparison of the thermal conductivity of laminates with different reinforcements.

Table II: Specific heats of the different materials

SRI No.	*Resin and reinforcement*	*Temperature range* °F.	*Specific heat* B.t.u./lb. °F.
1 - 1	Epoxy Glass	−64 to 491	0.272
1 - 2	Epoxy Glass	−93 to 495	0.283
2	Phenolic Glass	194 to 615	0.269
3	Silicone foam	195 to 697	0.325
4	Phenolic Glass	−50 to 705	0.300
5	Silicone Glass	−50 to 700	0.252
6	Phenolic Glass	−52 to 702	0.272
7 - 1	Phenolic Refrasil	−59 to 682	0.285
9	Phenolic Nylon	−50 to 499	0.470
10	Silicone Asbestos	−49 to 702	0.290
11	Phenolic Glass	−58 to 601	0.273
12	Epoxy Glass	−53 to 598	0.263
13	Phenolic Asbestos	−57 to 700	0.310

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Pro-fax is in the picture when heat resistance is a "must"

Resistance to heat from the projector light made Pro-fax a "must" for "Duojector." This new magnifier-projector for slides, artwork, photos, coins and stamps has a host of other plus features thanks to Pro-fax: compact, attractively styled, readily portable—since it's made with the lightest of all plastics—Duojector is virtually unbreakable, with a rich, colorful finish that is immune to staining and will withstand both use and abuse.

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Pro-fax hinges dispense with assembly costs

Pro-fax was a "must" in this unique dispenser-package for Permacel's RIBBON DOPE* Thread Sealant, a new sealer designed for use on threaded pipe joints. Four integrally molded hinges are combined in a single molded part which opens to accommodate a roll of RIBBON DOPE, then folds and locks together to make a lightweight compact carrier. A snap-in blade cuts tape to any desired length, and the handy unit can be tucked in pocket or tool box, stored in any convenient place, or kept available on the worktable. When product success hinges on functionality plus low cost, Pro-fax provides the *most* plastic for the job.

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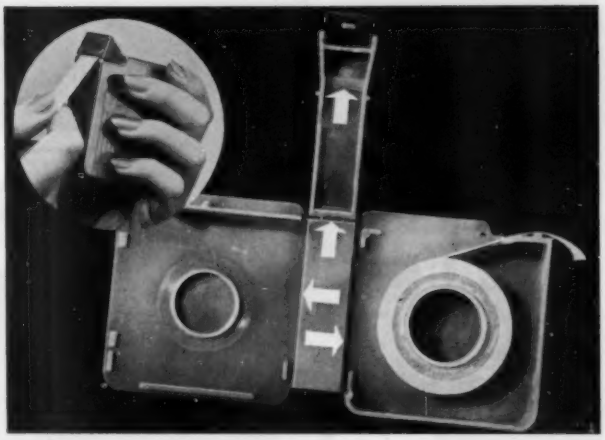

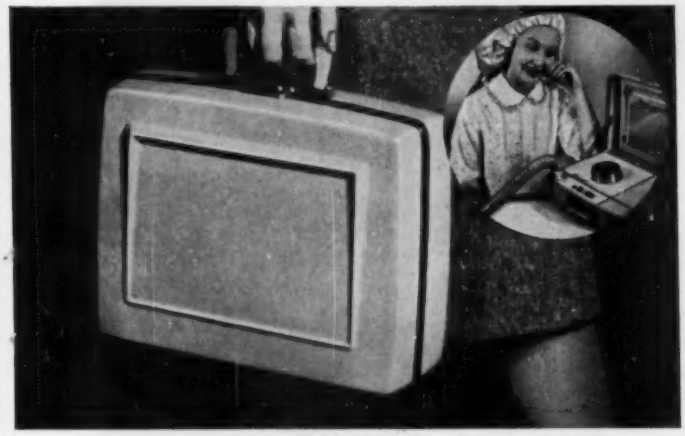

DOMINION makes a case for Pro-fax in portable home appliances

All of the advantages of Pro-fax which make it ideal for luggage—light weight, resilience, resistance to scuffing and staining—were needed in the case for Dominion Electric's new hair dryer. But UL listing was required, too. Dominion achieved this by the use of an intumescent coating, applied to the interior surface of this handsome injection-molded carrier. Result: A revolutionary new appliance, a veritable portable beauty salon, easily moved, usable anywhere.

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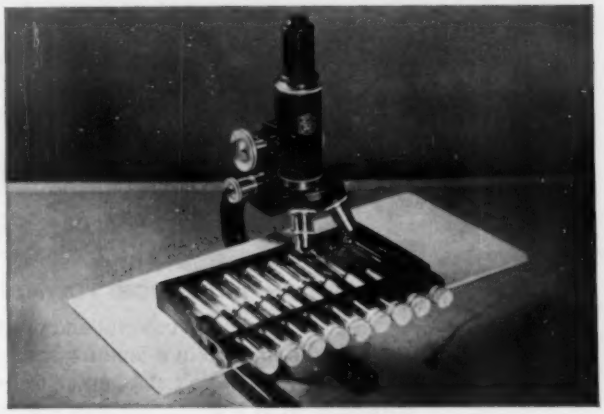
Many "musts" make Pro-fax the most

The combination of properties available in Pro-fax made this radical new concept in laboratory equipment a reality. Six of these molded "drawers," each holding nine culture tubes, nest in a compact case which permits handling 54 tubes at one time. They replace a cumbersome metal rack which required individual handling of each tube under the microscope and during subsequent cleaning and sterilizing. Pro-fax was a "must" for the resilient retainer rings which anchor test tubes firmly in place so that a full drawer can be studied, washed, and steam-autoclaved without removal. Pro-fax was a "must," too, for the built-in hinge catch on each drawer, designed to hold it in the six-drawer case. All these many "musts" have made Pro-fax the *most* plastic for a variety of new laboratory-ware applications, including test tubes, beakers, and a number of measuring devices.



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tion was not nearly so large as for the SRI 8 series. In the SRI 7 series, the percentage resin was higher and the densities lower, both of which would reduce the conductivities and mask the effects.

SRI 6 and 7-1 had practically identical conductivities (Fig. 11, p. 149) although they were reinforced with chopped glass squares and a continuous Refrasil weave, respectively, bonded with phenolic resin. Although specific conductivity data on the fibers is not available, vitreous silica (Refrasil) has about three times the conductivity of amorphous glass, indicating that the conductivity normal to a panel is probably primarily influenced by the resin and other variables rather than the fiber.

The conductivity of three phenolic-asbestos laminates of different density varied directly as the density at the lower temperatures (Fig. 12, above), as previously reported by Oglesby. As the temperature increased, however, the conductivities of the panels seemed to converge. This convergence was probably the result of resin deterioration and consequent masking of the density effect. Figure 13, right, is a direct plot of conductivity versus specific gravity and indicates clearly the major influence of density on conductivity. At temperatures of 1000° F. and over, the resin is probably completely deteriorated and only a residue and the reinforcement material remain, all with about the same conductivity. Figure 12 also shows the conductivity for these particular panels to 1200° F. This higher temperature does not exhibit the characteristic drop in conductivity for phenolic panels at about 700° F. Complete data on these laminates were not available, so it would be impossible to postulate why the conductivity of these panels did not decrease at 700° F.

Other observations can be made from the data in Table I and Fig. 9. Laminate SRI 11 had a much higher conductivity than SRI 9 at above 200° F. Both had the same phenolic resin, but SRI 11 had a glass filler, was subjected to a severe cure, and was very dense, whereas SRI 9 had a nylon filler, a mild cure, and was less dense. The higher conductivity of SRI 11 at the higher temperatures was probably the result of the combination of many factors. It is very difficult to select the major parameter if one does exist. From other observations, the conductivity of the filler material probably has a minor influence for heat flow normal to the filler. The higher values for SRI 11 are probably the result of its higher density (131 compared to 72 lb./ft.^{3}). The conductivity of the nylon-filled laminate probably decreases at above 200° F. because the nylon filler cures and then deteriorates **(To page 246)**

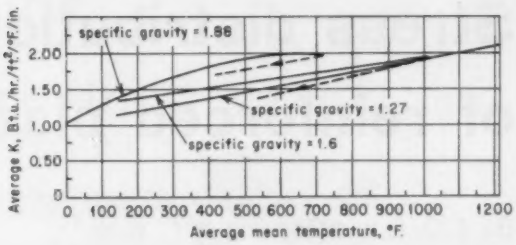

FIG. 12: Influence of density on the thermal conductivity of three asbestos-phenolic panels.

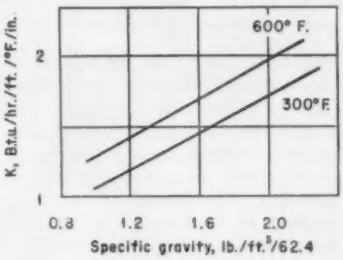

FIG. 13: Influence of the specific gravity on thermal conductivity of the phenolic-asbestos panels.

Table III: Physical appearance of materials before and after thermal conductivity measurements

Material SRI No	*Original appearance*	*Top temp*	*Appearance after test*
		°F.	
1 - 1 and	Light green	527	Black and brown areas with some de-
1 - 2			lamination
2	Medium brown	593	Black with resin completely burned out around edges
3	Light tan	704	Medium brown to black, crushed somewhat and cracked all over
4	Dark brown	780	Black with resin completely burned out in spots around edges and beneath getters
5	Mottled red	633	Mottled white and brown
6	Mottled medium brown and tan	725	Black
7 - 1	Tan	730	Black with resin completely burned out around edges
7 - 2	Tan	733	Black and delaminated in several places
8 - 1	Dark brown	730	Black with resin completely burned out
8 - 2		701	in spots
8 - 3		702	
9	Brownish yellow	732	Black; completely burned up; in small pieces
10	Grey	721	Light grey
11	Chocolate brown	586	Black, resin completely burned out around edges
12	Amber	599	Black, resin completely burned out around edges
13	Black	706	Black, with large white areas where resin was completely burned out

Stress distribution in the resin of reinforced plastics

By J. O. Outwater* and D. C. West**

Stresses in epoxy resin surrounded by touching glass filaments were examined by photoelastic techniques. The glass surface is under severe tension, resulting from the thermal shrinkage of the resin in an unyielding glass surround. This tension can be totally relieved by destroying the adhesive bond between the resin and the glass. And this tension can be markedly increased by postcuring. When the bond is broken, passages form through the laminate which can conduct water into its interior.

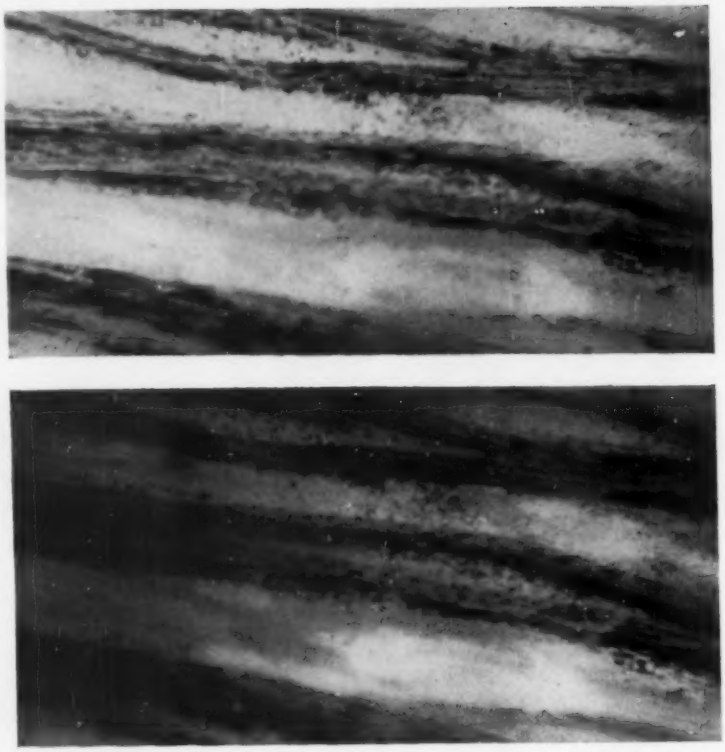

FIG. 1A (top); 1B (bottom): Microphotographs of glass-cloth-reinforced laminate, showing complete penetration of a fluorescent penetrant after specimen has been subjected to boiling water. The microphotograph at the top shows the effect of white light passing through the specimen; the lower photograph illustrates the effect of ultra-violet light on the dye as seen through a yellow filter, which eliminates all light except that at the fluorescent wavelength.

An understanding of the mechanics of reinforced plastics, its shortcomings, and its peculiar advantages can be understood better by an examination of the exact role of the resin surrounding the fibers. We have been prone to think of the fiber being embedded in a resin matrix. We have measured the pressures of the resin on the fibers(1)[1] and tried to deduce something of the behavior of the laminate from these data. A more careful examination of the laminate reveals that we may be in error in believing the properties to be predicated on the concept of the fibers being embedded in resin. Actually, it is the fibers themselves that are pressed together and touch each other with the resin in small pockets between the fibers.

Instead of the glass being under pressure from the resin, the glass is under severe tension from the resin shrinking as it cools. We shall see from data appearing later in this article that this tension is of the magnitude of several thousand p.s.i. and can be totally relieved by destroying the adhesive bond between the resin and the glass.

Seepage of water into a boiled laminate

If we immerse a glass fiber reinforced laminate in a fluorescent solution, no dye appears to penetrate except where the laminate has been mechanically damaged. If now we boil the laminate and then submerge it in the fluorescent solution, the dye penetrates into the laminate whether the specimen is hot or cold. Figures 1A and 1B, above, show two microphotographs of such a laminate that has been boiled in water and exposed to fluorescent penetrant.

Figure 1A was photographed in white light; Figure 1B was taken in ultra-violet light, showing the fluorescence only. Care has been taken to filter out all but the fluorescent wavelength. It can be seen that the two photographs are identical, implying that all the lines that we see in white light are due to small channels within the laminate which

*Prof. of Mechanical Engineering, University of Vermont, Burlington, Vt.
**Engineering Dept., E. I. du Pont de Nemours & Co. Inc., Newark, Del.
Based on a paper presented at the 16th Annual SPI Reinforced Plastics Conference, Chicago, Feb. 1961.
[1]Numbers in parentheses designate references at the end of article, p. 252.

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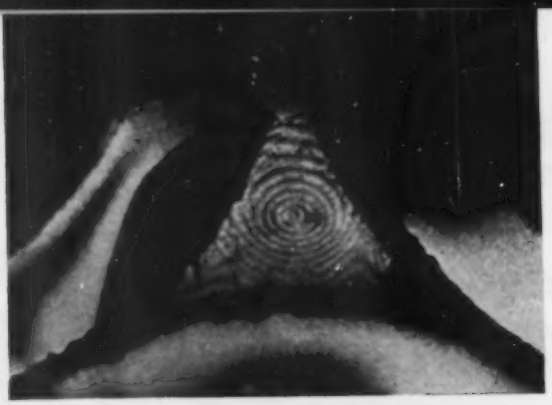
Fig. 2



FIGS. 2-9: Isochromatic fringe patterns of Epon 815 resin with 10.5 p.h.r. of Curing Agent D cast between glass cylinders. **Fig. 2:** At room temperature. **Fig. 3:** At 125° F. **Fig. 4:** At 145° F. **Fig. 5:** At 160° F. **Fig. 6:** At 190° F. **Fig. 7:** At room temperature after boiling. **Fig. 8:** At 120° F. prior to post-cure. **Fig. 9:** At 120° F. after post-cure for 12 hr. at 320° F.

Fig. 3

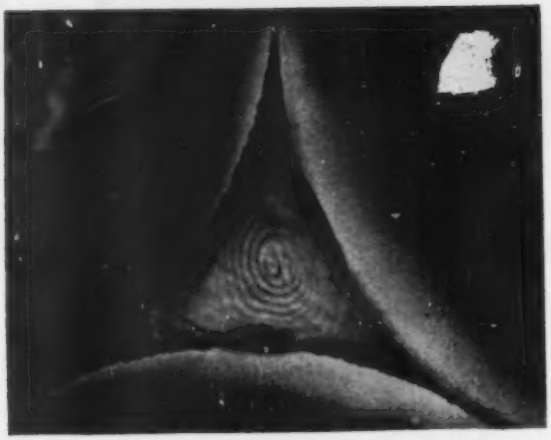


Fig. 4

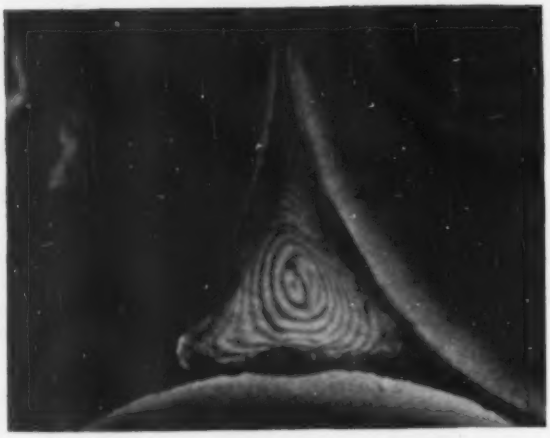
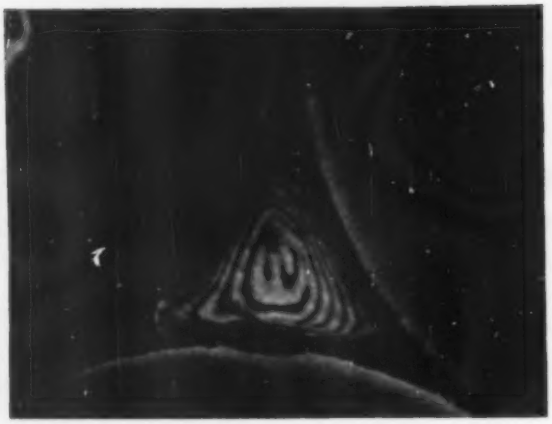


Fig. 5



are large enough to pass a penetrating liquid.

There appears then to be some irreversible change occurring within the laminate when it is boiled; small channels, which were not there before, open and do not again close. It is extremely important to determine the nature as well as the origins of these channels, as they can conduct glass-corroding material and are positive indications of laminate faults.

The laminate as a container of resin

If we examine carefully the distribution of resin and glass fibers in a laminate, we can see that the resin is found in two types of location. 1) It occurs in large pockets between ends or, in the case of cloth lay-ups, at the cross-overs of strands. 2) It lies within the fiber bundle itself, acting to hold the filaments together and to fill up the interstices between the filaments that comprise the ends. It is in this latter location that we shall examine its role more exactly, because it is at this point where the resin contacts the majority of the surface of the glass.

When the laminate is being made, the fibers are impregnated with resin and are then squeezed to force out the excess resin before curing. These squeezing forces tend to force the filaments together so that the resin is held in what may be considered a rigid glass walled container whose sides are the filaments themselves. In the case of optimum packing the resin will be shaped in the form of a triangle with concave sides which we shall refer to as a tricorne. It is in this small area of resin that we have measured the stress distribution and are showing below how some of the unexpected relation-

ships in properties of glass fiber laminates can be predicted upon the basis of this behavior.

Experimental procedure

Because of the small size of the resin inclusions between the fibers, it was considered impractical to use specimens of actual size. Therefore, scaled-up models were constructed using 1 in. diameter thick-walled Pyrex tubing which was clamped together in the form of three stacked fibers. Epon[2] 815 resin with 10.5 p.h.r. of Curing Agent D was cast in the area between them. The resin was cured for 24 hr. at 150° F. and the ends were subsequently polished flat so that circularly polarized light could be passed through the resin inclusion. To insure that there was no premature separation of the resin from the glass, the casting was carefully examined to insure that the bond was satisfactory.

The isochromatic fringe pattern at room temperature is shown in Fig. 2. (Figs. 2-9 appear at left and right). To show the origin of this stress distribution in the resin at room temperature, photographs were also taken at 125° F. (Fig. 3), 145° F. (Fig. 4), 160° F. (Fig. 5), and 190° F. (Fig. 6). In order further to show the origin of these stresses, the specimen was immersed in boiling water so that the resin would separate from the glass walls; Fig. 7 shows the fringe pattern in the resin tricorne at room temperature after the bond between the glass and the resin has been destroyed.

Further information was obtained on the effect of a post-cure at 320° F. for 12 hr.; Fig. 8 shows the isochromatic fringe pattern at 120° F. prior to a post-cure treatment and Fig. 9 shows the isochromatic fringe pattern at 120° F. after the post-cure treatment at 320° F. for 12 hours.

In order to interpret the stress patterns shown by the photoelastic fringes, it was necessary to determine the stress-optic coefficient of the resin at various temperatures. This was done by casting a rectangular bar of the pure resin and observing the fringe pattern while it was being bent in the path of circularly polarized light. Figure 10, p. 250, shows **(To page 250)**

[2]Tradename of Shell Chemical Corp.

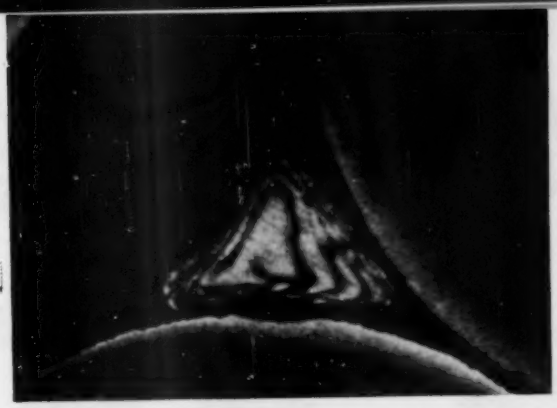


Fig. 6

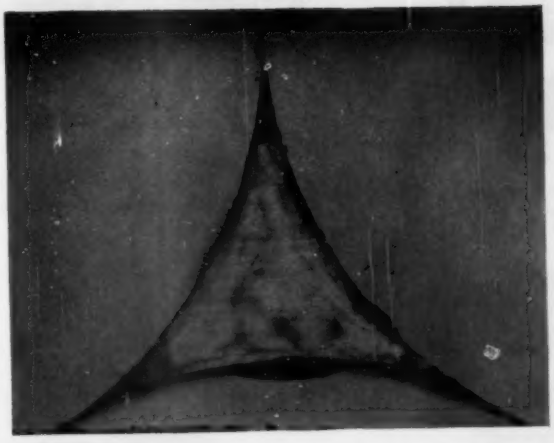


Fig. 7

Fig. 8

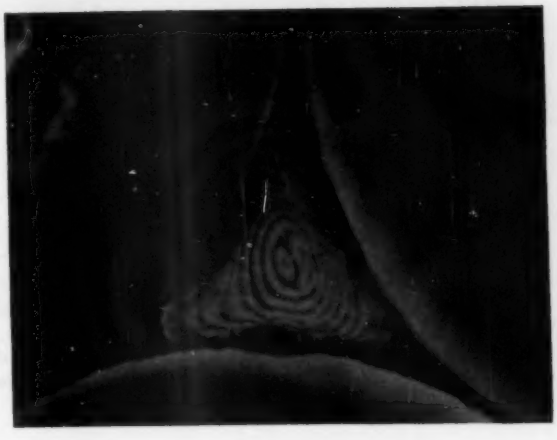


Fig. 9

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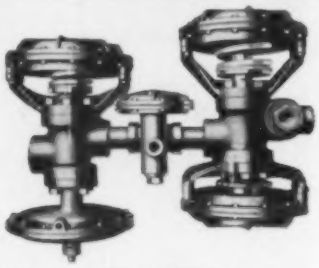
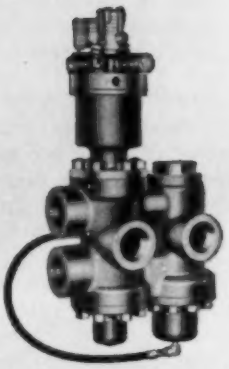
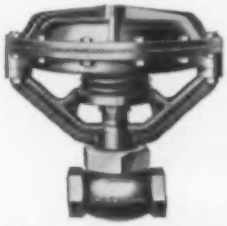


4,000 PSI, 3-WAY AUTOMATIC 2-pressure, auto-neutral, throttling, ½ - 3 in. NPT.



3,000 PSI, 4-WAY SEMI-AUTOMATIC air operated, handles oil, water, glycol-base fluids, 1 - 2 in. NPT.



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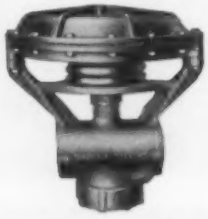

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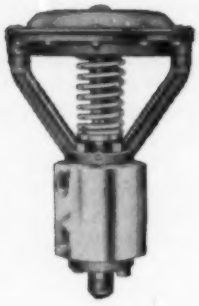

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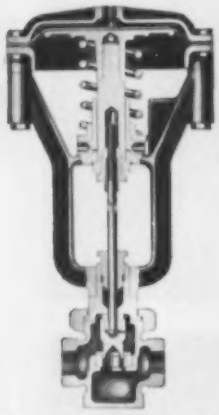

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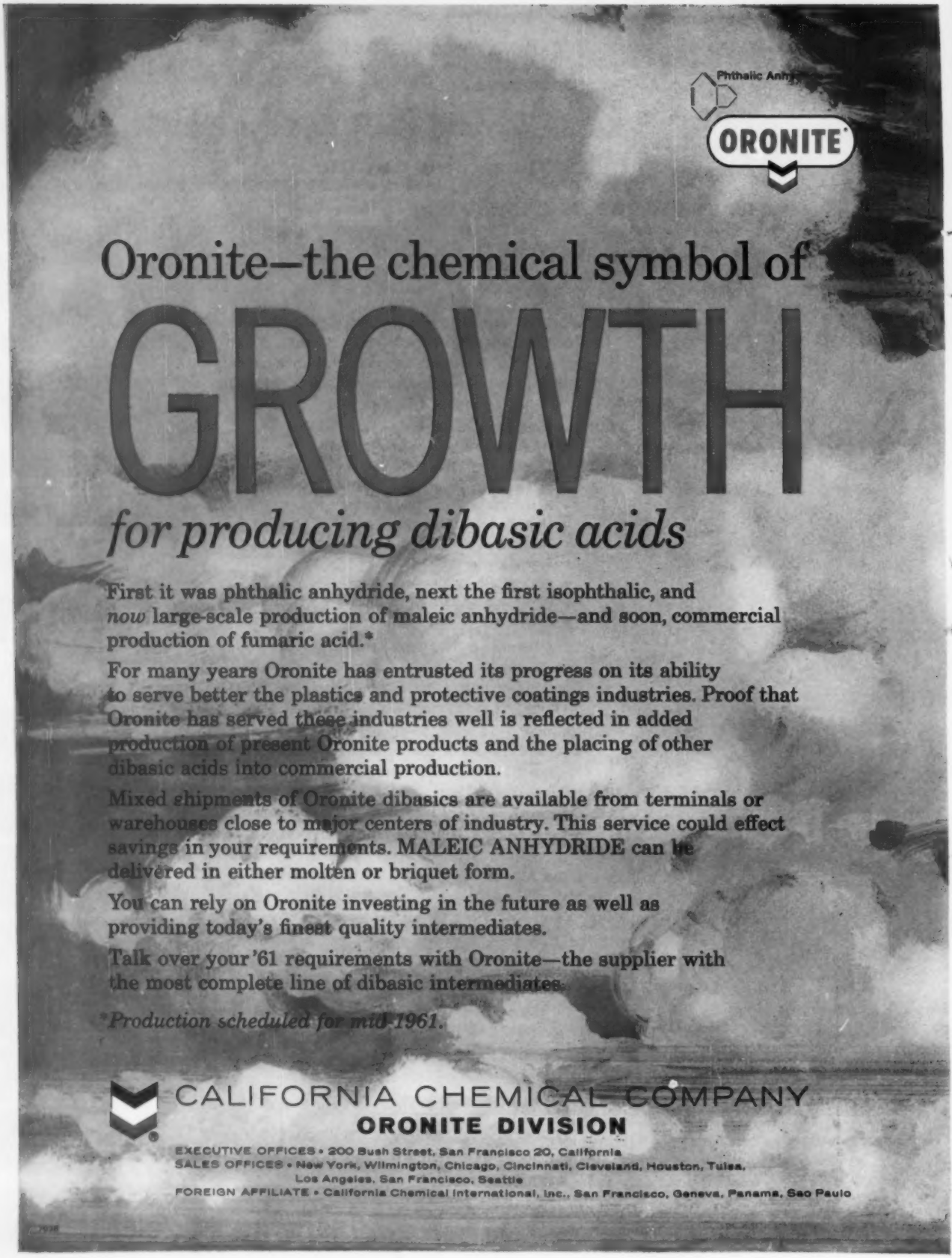
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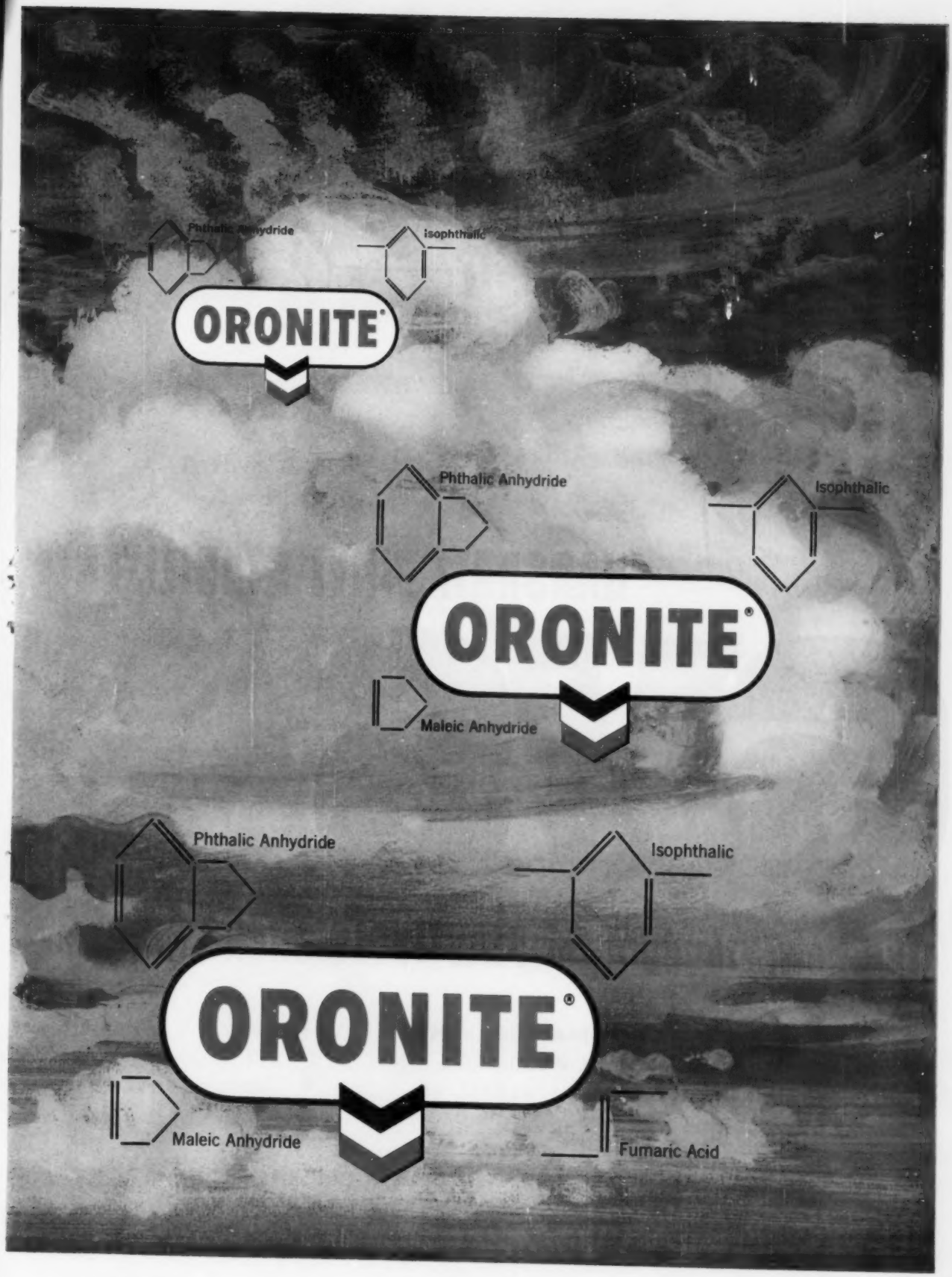
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H.I. 725

M.I. 625

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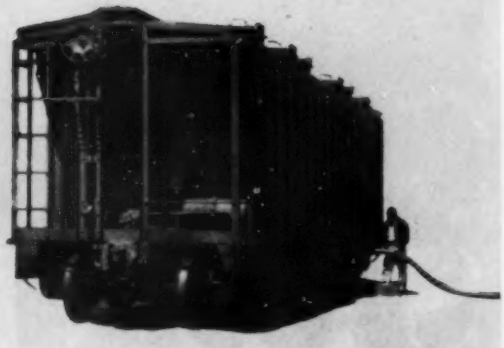
GPC 500



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The plasticizer market in review

By William J. Reid*

Plasticizer output reached a new high in 1960, according to preliminary Tariff Commission figures recently made public.

Essentially all of the output was consumed in the U. S., where demand is estimated to have been 590 million lb. (see Fig. 1, below), slightly below a reported U. S. production of 602 million pounds.

The published sales figure for 1960 was 500 million lb., 102 million lb. below production. The difference can be attributed primarily to captive use.

Vinyl plastics continue to be the major consumer of plasticizers, accounting for 73.5% of demand in 1960, up slightly from the 70% average of the last 10 years (see Table I, p. 170). Estimated consumption in vinyl plastics by end-use is shown in Fig. 2, below.

U. S. plasticizer demand was up 9% over the 1959 figure of 540 million pounds. During the last 10 years, demand has grown at an average annual rate of 9.3% per year. The strong growth results from the rapid advance of vinyls in the U. S. plastics market. Preliminary U. S. Tariff Commission figures indicate that 1960 sales of PVC and copolymers were 1,130 million lb., the major part of which is plasticized.

The plasticizer industry generally classifies plasticizers into six major groups: phthalates, phosphates, resinous (or polymeric plasticizers), low-temperature diesters, epoxies, extenders, and a miscellaneous group. Estimated U. S. consumption by major types is shown in Table II, p. 172, and by major end-use market as indicated in Fig. 3, p. 167. The U. S. Tariff Commission divides plasticizers into two principal groups, cyclic and acyclic plasticizers. The Tariff Commission reports production and sales of phthalates, phosphates, and low-temperature diesters; however, resinous, epoxy, and miscellaneous plasticizers may be obtained only through inspection of published Tariff Commission data and analysis of end-use markets.

Cyclic plasticizers

Phthalic anhydride esters continue to dominate the industry as the major class of plasticizers. Tariff reports a 1960 production of 345 million lb., roughly 58% of total U. S. plasticizer production. The largest portion of phthalate plasticizers, 260 million lb., were consumed in vinyl plastics.

Dioctyl phthalates remain as the industry's most important family of plasticizers. In 1960 di(2-ethylhexyl) phthalate continued its well-established position as the leading plasticizer and bellwether of the plasticizer industry. The Tariff Commission indicates that 1960 DOP production amounted to 123 million lb., a sizable increase over 1959.

Diisooctyl phthalate production remained about the same as 1959 at 46 million pounds. Diisodecyl phthalate production amounted to 36 million lb., an increase of 24% over 1959. The product has grown rapidly since its introduction in 1953. Generally good performance, including low volatility and good electrical properties, make DIDP well-suited for wire coatings and other vinyl uses including film, sheeting, contour extrusions, and molded products.

Ditridecyl phthalate made its first appearance in the Tariff Commission report in 1960. This product is used primarily in high-temperature vinyl wire coating applications.

Tariff Commission reports a large increase in the octyl decyl phthalate category amounting to the 6 million lb. above the n-octyl n-decyl phthalate figure normally expected in recent Tariff Commission reports. It is believed that the sudden increase in octyl decyl phthalates is partially accounted for by the industry's effort to extend some raw materials which were short in 1960.

Dicapryl phthalate production

*Assistant Manager, Market Research, Union Carbide Chemicals Co.

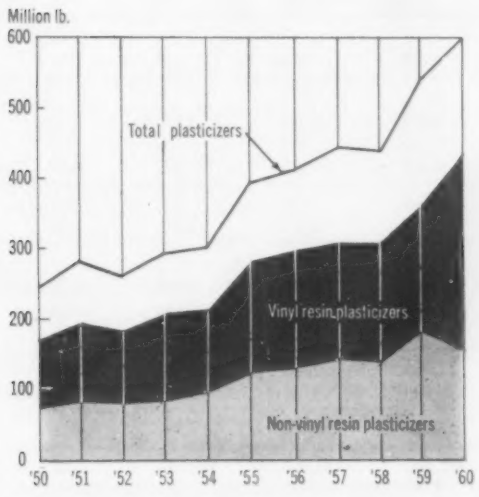


FIG. 1: Estimated consumption of plasticizers in the U. S. for 10-year period.

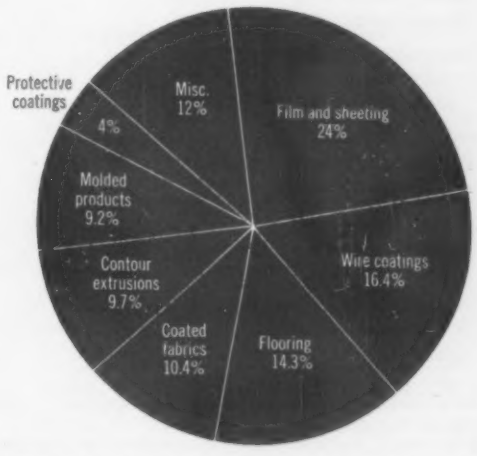
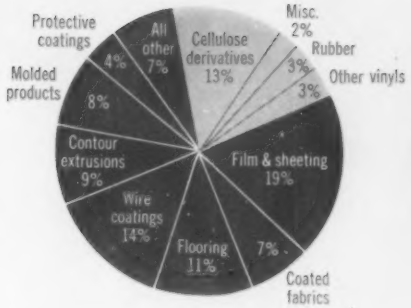


FIG. 2: Estimated U. S. consumption of plasticizers in vinyl plastics applications for 1960.

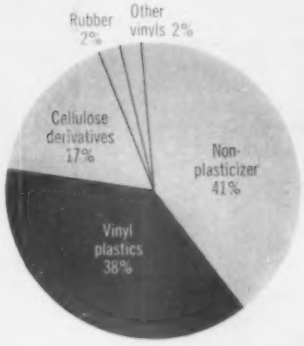
United States Production of Plasticizers[a]

	Production 1000 lb.					Unit value[b] 1960 ¢/lb.
	1956	1957	1958	1959	1960	
Phosphoric acid esters						
Tricresyl phosphate[c]	32,265	29,944	26,463	31,375	32,485	0.30
Triphenyl phosphate	8,318	8,991	8,023	8,427	9,466	—
Cresyl diphenyl phosphate	—	—	7,222	10,525	12,874	0.28
Phthalic anhydride esters						
Butyl decyl phthalate	3,869	4,582	10,573	—	4,752	0.24
Butyl octyl phthalate	—	—	—	—	13,190	0.25
Dibutyl phthalate	22,017	17,702	12,902	15,130	18,946	0.27
Dicapryl phthalate	3,667	—	—	—	4,364	0.26
Dicyclohexyl phthalate	—	5,994	6,771	6,683	5,777	—
Diethyl phthalate	18,661	18,281	14,454	16,128	16,767	0.24
Diisodecyl phthalate	17,038	24,431	23,372	28,777	35,538	0.26
Di(methyl cellosolve) phthalate	3,247	2,388	2,702	2,991	—	—
Di(2 methoxyethyl) phthalate	—	—	—	—	3,855	0.36
Dimethyl phthalate	4,037	3,293	3,494	3,318	3,386	0.25
Ditridecyl phthalate	—	—	—	—	582	0.33
Dioctyl phthalates						
Di(2 ethylhexyl) phthalate	80,632	73,568	76,729	104,811	123,396	0.25
Diisooctyl and mixed octyl phthalates	31,029	39,527	34,111	41,977	46,824	0.25
Octyl decyl phthalates						
n-Octyl n-decyl phthalate	—	—	—	10,291	10,067	0.28
iso-octyl iso-decyl phthalate	—	—	—	4,772	6,276	0.24
All other phthalic anhydride esters[d]	41,916	48,236	42,063	58,954	51,021	0.28
All other cyclic plasticizers[e]	37,378	39,084	33,053	46,372	45,178	0.33
TOTAL CYCLIC PLASTICIZERS	315,343	329,290	312,225	395,934	444,744	0.27
Adipic acid esters						
Diisodecyl adipate	1,150	1,294	1,963	2,989	3,167	0.40
Di(2-ethylhexyl) adipate	1,128	1,828	1,731	1,726	3,040	0.39
Octyl-decyl adipate	—	—	1,137	1,770	4,983	0.39
Diisobutyl adipate	—	359	—	—	—	—
Complex adipic acid polyesters	—	—	—	3,068	4,794	0.44
Diisooctyl adipate	2,218	1,833	2,134	3,561	4,233	0.39
All other	4,008	3,668	2,494	3,723	1,919	0.44
Azelaic acid esters						
Di(2-ethylhexyl) azelate	—	—	—	7,091	6,304	0.46
All other	—	—	—	987	991	—
Dibutyl maleate					5,519	—
Glyceryl monoricinoleate	301	334	328	430	298	0.36
Oleic acid esters						
Butyl oleate	1,858	2,006	1,179	2,101	1,822	0.22
Methyl oleate	693	817	—	948	664	—
All other	7,533	7,210	4,828	4,260	3,733	0.29
Palmitic acid esters	—	—	2,606	2,904	—	—
Phosphoric acid esters	6,565	10,221	7,327	8,231	9,481	0.41
Sebacic acid esters						
Dibutyl sebacate	3,111	3,595	—	3,993	3,596	0.63
Di(2-ethylhexyl) sebacate	—	—	—	—	9,178	0.59
All other	8,591	8,958	—	5,976	1,007	0.59
Triethylene glycol di(caprylate-caprate)	1,440	2,315	1,659	2,688	2,009	0.38
All other acyclic plasticizers	42,789	52,721	54,890	66,980	78,365	0.37
TOTAL ACYCLIC PLASTICIZERS	161,455	112,916	105,719	128,035	157,391	0.39
GRAND TOTAL	416,788	442,206	417,944	523,969	602,135	0.30

[a]All figures are from U. S. Tariff Commission reports. [b]Calculated on rounded figures. [c]Includes material produced for use as motor fuel additive. [d]Reported under azelaic acid esters in previous years. [e]Includes data for phthalic anhydride esters of phenol, cyclohexanol, fatty alcohols, mono and dihydric alcohols, cellosolves, and phthallyl glycollates.



PHTHALATES



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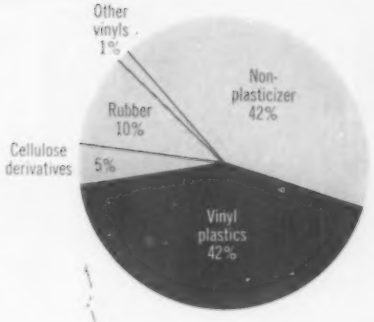
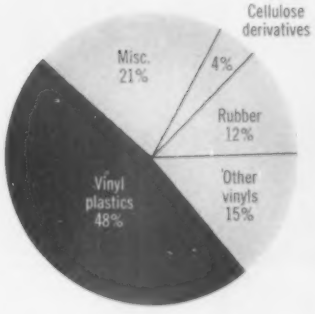


LOW-TEMPERATURE DIESTERS

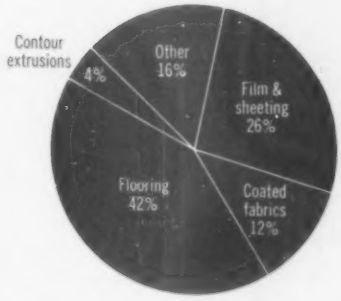


EXTENDERS AND MISC.

was reported as 4.4 million pounds. Supply of this product is limited by the amount of by-product capryl alcohol available from castor oil splitting to produce sebacic acid.

Other phthalates, used principally in the manufacture of vinyl flooring, are butyl benzyl phthalate, butyl octyl phthalate, and butyl decyl phthalate. The ability of these products to wet resin and filler is a valuable processing aid in the manufacture of such products as vinyl asbestos tile. Butyl benzyl phthalate is the largest volume plasticizer in this group and accounts for the major portion of the Tariff designation "all other phthalic anhydride esters." Dibutyl phthalate production increased over 1959 as a result of improved conditions in the nitrocellulose lacquer market. Dicyclohexyl phthalate production declined slightly from 1959, reflecting slackened growth of cellophane under pressure from other plastic films. Production of all other types of phthalate plasticizers remain essentially the same as 1959.

Phosphoric acid esters are used as plasticizers, oil and gas additives, and functional fluids. **(To page 170)**



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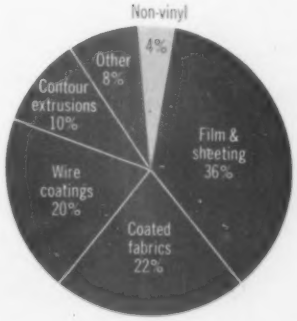

RESINOUS

FIG. 3: Tariff Commission estimates of 1960 consumption of plasticizers by major end-use markets.

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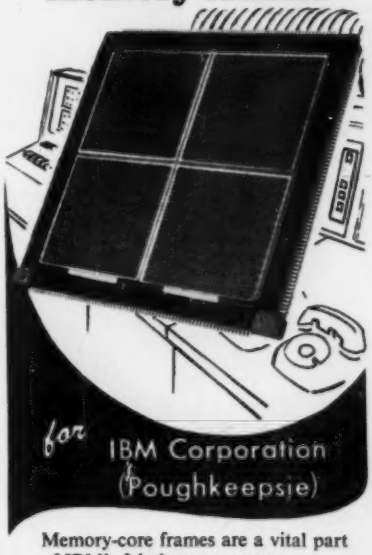

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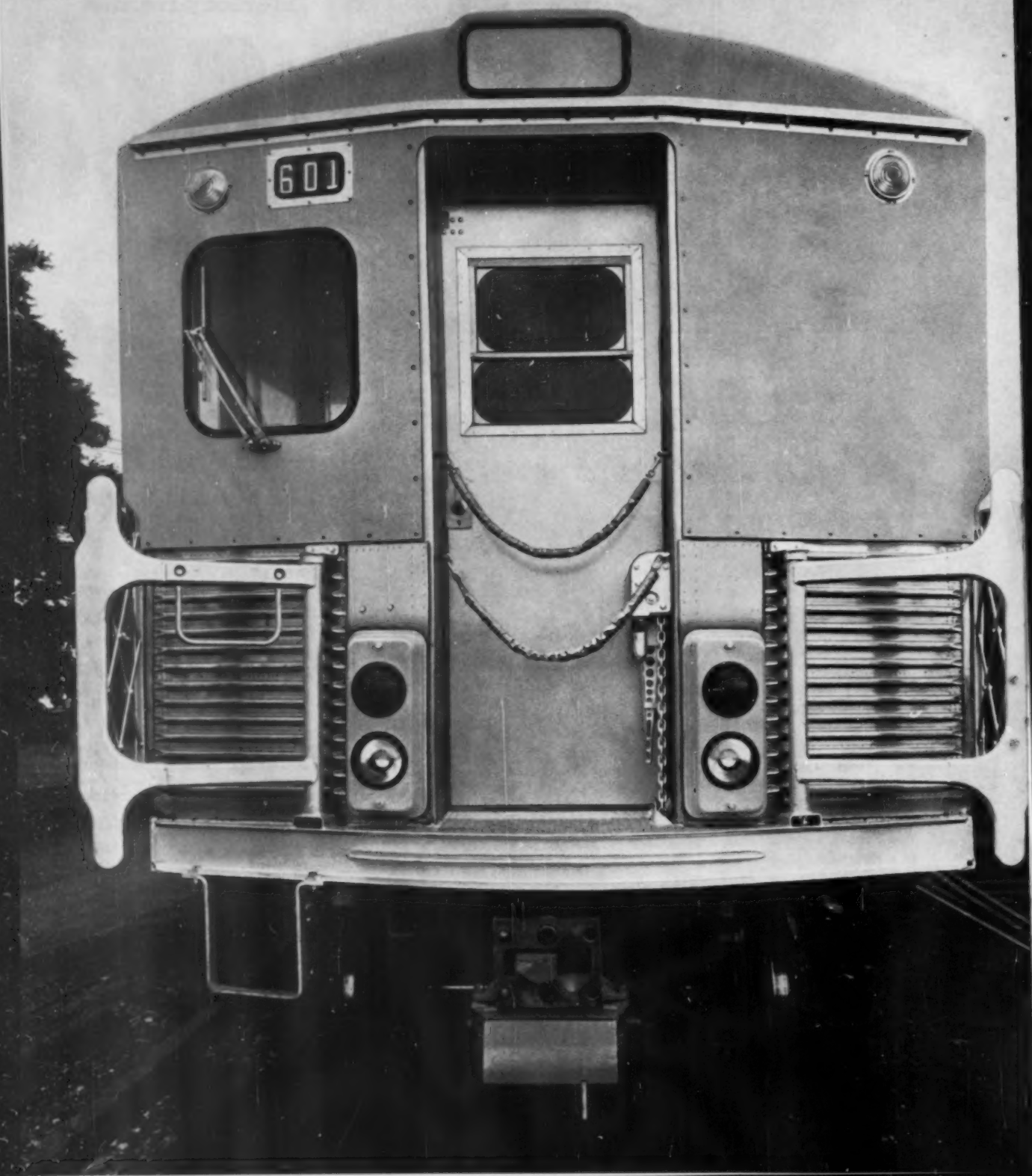
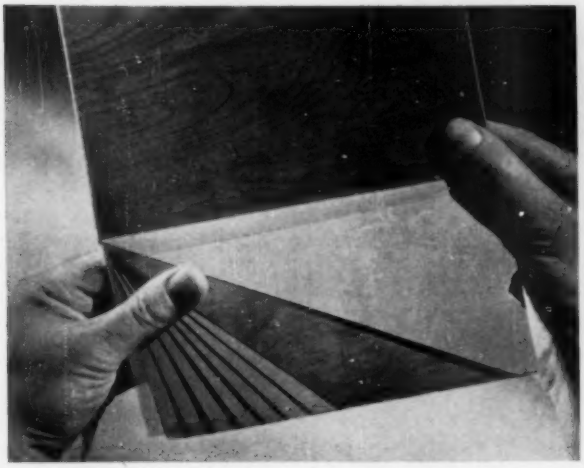
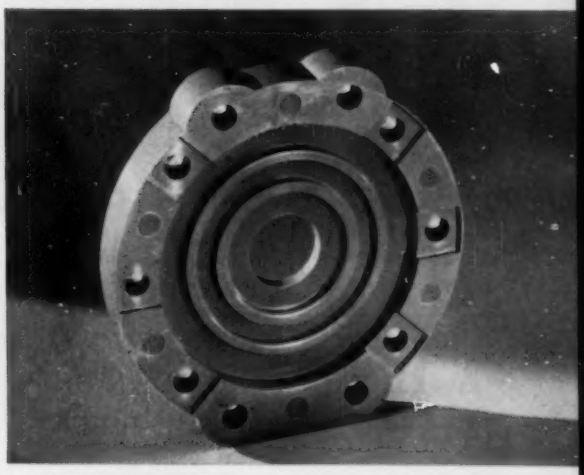


ASSEMBLE IT FAST with molded phenolic parts that fit together accurately, meet close tolerances—and **stay** that way through 300°F heat, subzero cold, soaking, and years of hard use. Whether the prime problem is heat, shock, moisture, corrosion, or any of a dozen others—your molder can apply one of more than 100 Durez molding compounds to come up with the properties you want.

WHIP CORROSION with rugged plastic parts that actually outperform and outlast metal. This molded base for a pump must—and does—cope with acids, oils, alkalies, and soapy water. It's made of Durez high-impact phenolic—one of a family of new materials proved in automotive transmission parts and in many other roughhouse applications.



ADD BACKBONE to a paper-base laminate by impregnating its core layers with liquid Durez phenolic resin. Hard, stiff sheets made this way don't behave like paper at all. They can stand a two-hour boiling in water; shrug off attack by alcohol, gasoline, and other solvents; stay smooth, flat, and serviceable for years.



TAME HIGH VOLTAGE with the least possible bulk and weight. Electrical components that mustn't fail—like this low-corona spacer for a trans-Atlantic telephone cable switch—depend on Durez diallyl phthalate compounds for their high surface resistivity, insulation resistance, indifference to moisture, virtual freedom from cold flow and creep.

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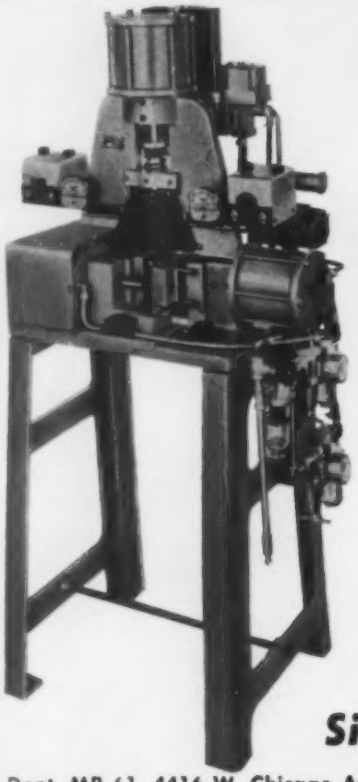

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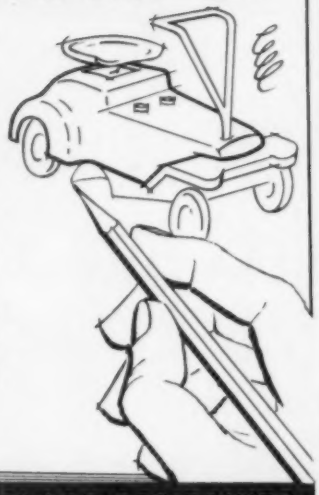

MOLDED FIBER GLASS COMPANIES

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U. S. consumption of cyclic phosphates was 55 million lb. in 1960, of which about 35 million lb. were used as plasticizers. Tricresyl phosphate has long been used by the industry as a flame-retardant plasticizer for vinyl and cellulose products. Cresyl diphenyl phosphate is often used in preference to TCP because it imparts better flexibility, is slightly more efficient, and has better light stability. Triphenyl phosphate is used, among other things, as a flame-retardant plasticizer for cellulose acetate.

Other miscellaneous cyclic plasticizers include camphor, sulfonamide plasticizers, tetrahydrofurfural oleate, chlorinated aromatics, phthalyl glycolates, and a variety of aromatic extenders.

Acyclic plasticizers

Aliphatic diesters are the principal low-temperature plasticizers used in the industry. In 1960 these products accounted for 6.5% of total plasticizer consumption. Aliphatic diesters are also used as jet lubricant base fluids.

Adipic acid esters are widely used in the industry as low-temperature plasticizers for vinyl, rubber, and other resins. Principal products are di(2-ethylhexyl), diisooctyl adipate, and diisodecyl adipate. Dioctyl adipates are also used as base fluids for jet aircraft lubricants, which accounts for the major part of the reported adipate production increase in 1960 over 1959.

Azelate esters are used as low-temperature plasticizers for vinyls and as jet lubricant base fluids. Reported 1960 production declined somewhat from 1959.

Acyclic phosphoric acid esters include tri(2-ethylhexyl), tributyl, triisobutyl, tripropyl, trichlorethyl, tributoxyethyl, and triethyl phos-

Table I: 1960 plasticizer consumption by end use

	Million lb.	*Percent of total*
Vinyl plastics	434	73.5
Cellulose derivatives	60	10.0
Rubber	29	4.9
All other vinyls	22	3.9
Miscellaneous and non-plasticizer uses	45	7.7
Total	**590**	**100.00**

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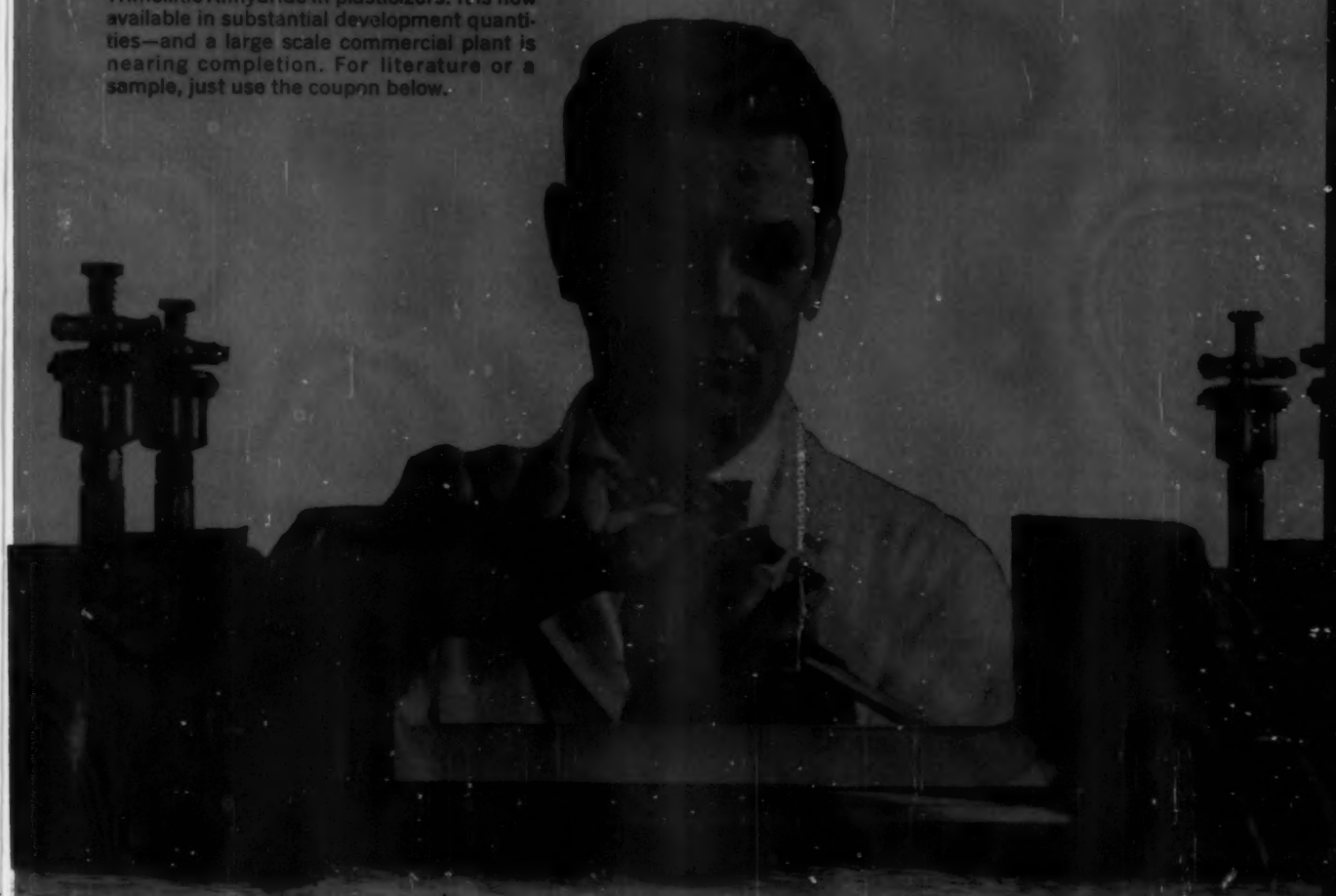
Why don't you investigate the use of AMOCO Trimellitic Anhydride in plasticizers. It is now available in substantial development quantities—and a large scale commercial plant is nearing completion. For literature or a sample, just use the coupon below.



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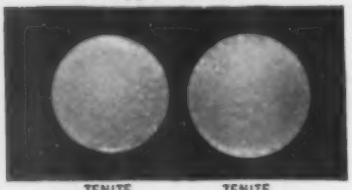
Copper Dish Test



TENITE POLYPROPYLENE 4232 CONTROL

TENITE POLYPROPYLENE 4232 1 HR. AT 185°C.

The chief reason Tenite Polypropylene resists oxidation so effectively is that it is manufactured by a unique Eastman process that leaves consistently less than 0.01% ash in the product. This low ash content also means a low electrical dissipation factor. And for molded products, low-ash Tenite Polypropylene lets color stand out rich and bright.

Of course, we add very small amounts of appropriate materials to improve certain properties—but without additives, Tenite Polypropylene is 99.99% pure. It floats, too, in case you're interested.

Vacuum Forming Polypropylene

Here is a helpful hint for vacuum forming polypropylene plastic sheet. Screen both upper and lower heaters with 8-gauge stainless steel mesh. This will help distribute the heat evenly and eliminate "hot spots" which sometimes cause sheet to rupture when vacuum is applied. A sheet 100 mils thick reaches forming temperature in about 30 seconds when held between two mesh-covered heaters at 1075°F. For a tough and durable vacuum-formed product, use sheet extruded from a high-impact formulation of Tenite Polypropylene.

Unsolicited Testimonial

Recently, on a lonely park lane, a company installed an experimental street light globe fabricated of Tenite Butyrate plastic. The lane, as it turned out, was a popular rendezvous for young lovers. One morning the globe was found badly battered.

Evidence indicated that someone had tried to put out the light with a stone. Failing in this, the person climbed the pole, threw the globe to the ground, and smashed the light. The globe, however, was still unbroken, so the vandal put it against the curb and ran over it with his car. He was apparently impressed by the strength of the plastic material because he wrote a little note which he stuck in the battered globe before putting it back on the pole. The somewhat colorful language in the note prevents our quoting it directly, but the gist of it was that to break one of these new plastic globes was just too much trouble.

The resistance of Tenite Butyrate to shock is so great that even when globes are pierced by BB shot and small bullets, they remain in a serviceable condition. For this reason, New York City's orange-colored light globes are now being made of Tenite Butyrate. These are the globes that are mounted atop a pole to indicate the location of fire-alarm boxes.

Special outdoor formulations of Tenite Butyrate combine weather resistance, rigidity, and excellent light-transmission and diffusion properties with an Izod Impact Strength as high as 2.0 ft. lb./in. of notch in an MH flow. This combination is unexcelled among thermoplastics for serviceability in such uses as street-light globes, outdoor signs, and lenses for automobile taillights, railway signals, and traffic-control lights, to name but a few. For more information about Tenite Butyrate for outdoor applications, contact your nearest Tenite representative or EASTMAN CHEMICAL PRODUCTS, INC., Plastics Division, KINGSPORT, TENNESSEE.

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Table II: 1960 plasticizer consumption by chemical type

	Million lb.	*Percent of total*
Phthalates	340	57.5
Phosphates	65	11.0
Resinous	36	6.2
Low-temperature diesters	38	6.5
Epoxies	38	6.5
Miscellaneous and extenders	73	12.3
Total	**590**	**100.00**

phates. Production increased 1 million lb. over 1959.

Sebacic acid esters are used as plasticizers and jet lubricant base fluids. Production increased slightly over 1959. The major part of this increase went to jet aircraft lubricants. Plasticizer applications accounted for a little less than 5 million pounds.

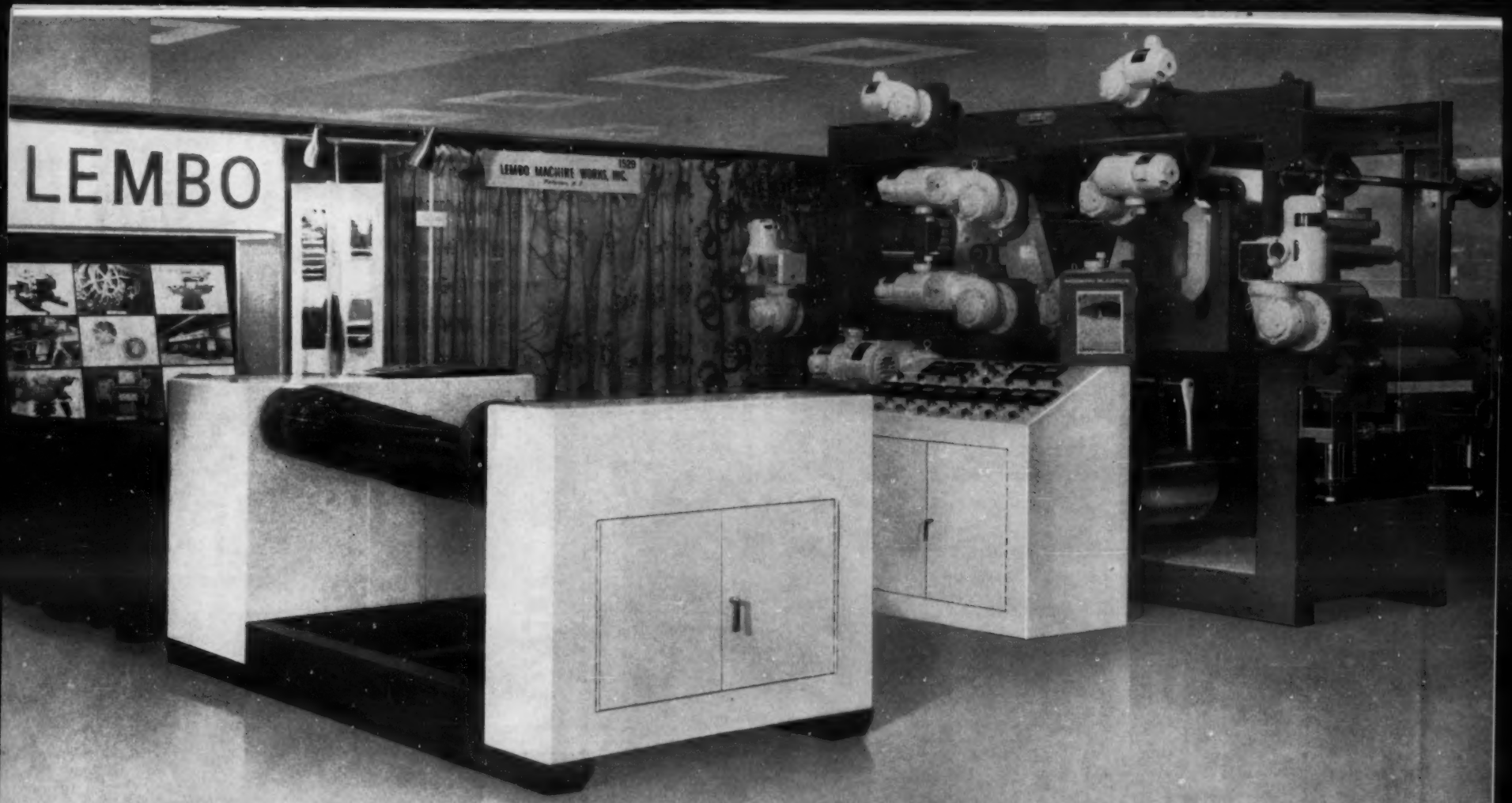
Stearic acid esters are used as plasticizers and lubricants for rubber, cellulose derivatives, and other resins. 1960 production declined from 1959.

Epoxy plasticizers, which are partially included in the Tariff designation "all other acyclic plasticizers," are estimated to have been used to the extent of 38 million lb. in 1960. This category includes two major types, epoxidized oils and alkyl epoxy stearates. More than half of 1960 production is estimated to have been epoxidized soybean oil. Vinyl plastics consumed essentially all of the epoxies produced. Flooring alone accounted for 41% of 1960 estimated consumption.

Resinous plasticizers are accounted for in the Tariff Commission designation "all other acyclic plasticizers" and under "adipic acid esters." Total 1960 production of resinous plasticizers was about 36 million lb., essentially all of which were consumed in vinyl plastics.

Remaining acyclic plasticizers include citrates, tartrates, ricinoleates, palmitates, esters of triethylene glycol, esters of fatty acids, and a variety of specialty plasticizers and extenders. Extenders have many uses, with vinyl plastics accounting for 48% of 1960 consumption.

The outlook for plasticizers hinges largely on the growth of vinyls. Industry sources expect a record year for vinyls in 1961 and 1962.—**End**



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Nuclear weapons training aids made of plastics

By Arthur M. Ayvazian*

Recently, Watertown Arsenal Laboratories was designated to fabricate five full-scale prototype models of two new nuclear weapons (one is shown in Fig. 1, below), which were to be produced by the Ordnance Weapons Corps. These prototype models were to be employed as training devices to provide the users and maintenance personnel with a first-hand concept of these new developments. The devices had to be 1) sufficiently detailed to present to the trainees the pertinent information; 2) strong and durable for reasonable handling in classroom instructions; and 3) produced within a certain cost. Only plastics could meet these three requirements. Three different materials were selected: Epoxy resin; acrylic sheets, rods, and tubes; and nylon sheets, rods, and tubes.

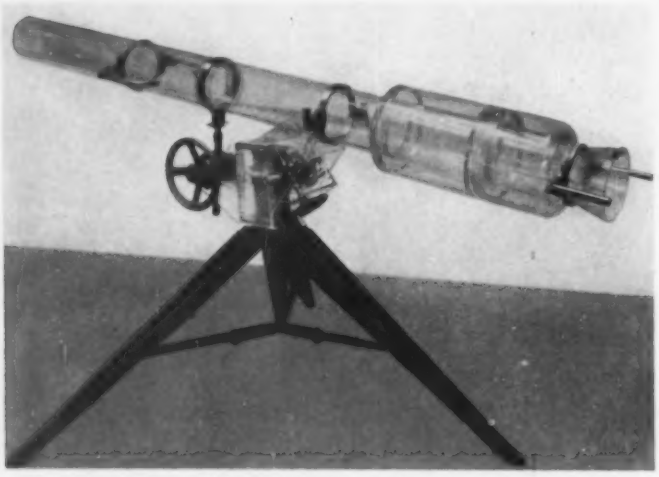


FIG. 1: One of two training-aid prototypes of nuclear weapons produced from epoxy resins and sheets, rods, and tubes of acrylic and nylon.

FIG. 3: Epoxy castings of the type used in prototype weapons.

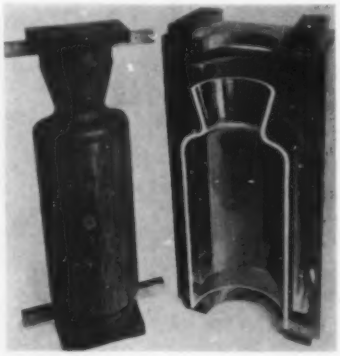


FIG. 2: Mating dies of the type used in forming Venturi configurations of acrylic sheet.

Acrylic parts

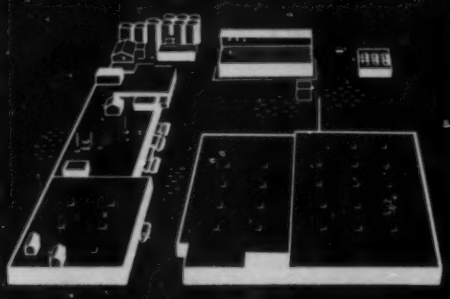
The important dynamic mechanisms of the training devices were enclosed in acrylic shapes in order to be visible to the viewer. The rear Venturi configurations were formed from ⅜-in. acrylic sheet pressed over proper mating dies of the type shown in Fig. 2, below. The process involved heating the premeasured sheets to 350° F. for 30 min. in an oven, placing them between the dies and then applying sufficient mechanical pressure to form the unit. After cutting the excess material from the sides, the two formed halves were taped together and the ends machined to concentricity. In each case, an acrylic tube was inserted into the Venturi configuration and all contacting surfaces cemented together. If the forming temperature was too low, the material was hard to form, requiring excessive pressures, and on cooling, exhibited defective surfaces in the form of stress lines. Sheet heated above the forming temperature on cooling, revealed discolored surfaces and cloudy areas. In cementing acrylic parts, the surfaces which were to come in contact had to be machined to a fine finish. The cement was applied to these surfaces and after a short interval, the parts were placed together and pressure applied. When cement was not applied properly and pressure not evenly distributed, "crazing" appeared.

Epoxy parts

Many of the components were cast and laminated with epoxy resins. Sound castings were obtained when the plaster molds were properly gated and the resin prepared according to manufacturer's instructions. The low shrinkage factor and good dimensional stability of this material made it possible to cast components to size, thereby eliminating many of the machining

*Watertown Arsenal, Watertown, Mass.

VINYL RESINS



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hours. Some of the complicated epoxy resin castings are shown in Fig. 3, p. 174. If these components were made from other materials the cost would increase two to three times, essentially because of the many additional hours of special machining which would be involved. Another advantage was that some of the costly intricate castings were easily repaired. However, several disadvantages were noted. When proper handling precautions were not taken, the irritation potential of the curing agent presented a problem to the skin. Also, the epoxy castings and machined epoxy components were brittle unless laminated or reinforced with glass fibers, necessitating extreme caution when machining or handling thin-walled components.

All the components cast for this work were prepared in a similar manner: 1) A wooden pattern of each castable component was fabricated. Depending on the item, these patterns were either one- or two-part patterns placed in wooden boxes. The boxes had removable sides and both the patterns and boxes were constructed with a certain amount of draft or taper depending on the size of the casting, to facilitate releasing of mold; 2) Molds were then made of the patterns by pouring a casting plaster into the well-waxed boxes. This plaster was prepared by mixing a predetermined water-plaster ratio; 3) After the plaster molds had set for about 30 min., they were released from the boxes; 4) Curing cycles of 12 to 15 hr. in a warm oven or 36 to 48 hr. at room temperature were used. Prior to pouring the epoxy resin, the plaster molds were thoroughly treated with a conventional release agent; 5) The technique of preparing the resin for pouring demanded special precautions. Vigorous stirring brought considerable amounts of small air bubbles to the surface of the resin which, on hardening, resulted in a porous casting.

To alleviate this condition, the pouring time was delayed in order to allow the release of as many air bubbles as possible from the body of the mixture. The surface of the mixture was then slightly skimmed, removing the porous layer, before pouring.

The legs of one weapon mount were constructed with epoxy-impregnated glass cloth tubing. The tubing was fabricated by wrapping the impregnated glass cloth around a four-piece wooden mandrel to the thickness desired. After the reinforced resin set, the mandrel was collapsed and pulled out, leaving a tubing of predetermined inside diameter. The outer surface was machined to desired dimensions.

Nylon parts

Gears ranging from 1½ to 7 in. in diameter were machined from sheets and rods of this tough material. The cutting tools required negative rake angles. The gears had to be sufficiently strong to support and elevate a weight of around 100 lb. to a height of at least 1 ft. from the horizontal. Strength-wise, the material easily performed its task. Some knowledge of machining this plastic was necessary to obtain fine surface finishes. Techniques which differed from normal practices were involved.—**End**

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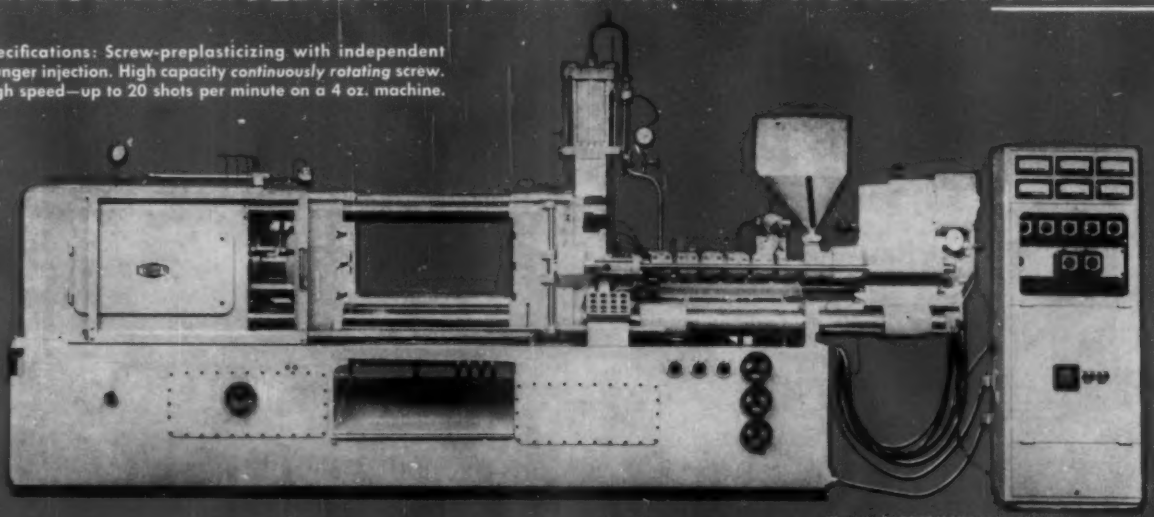

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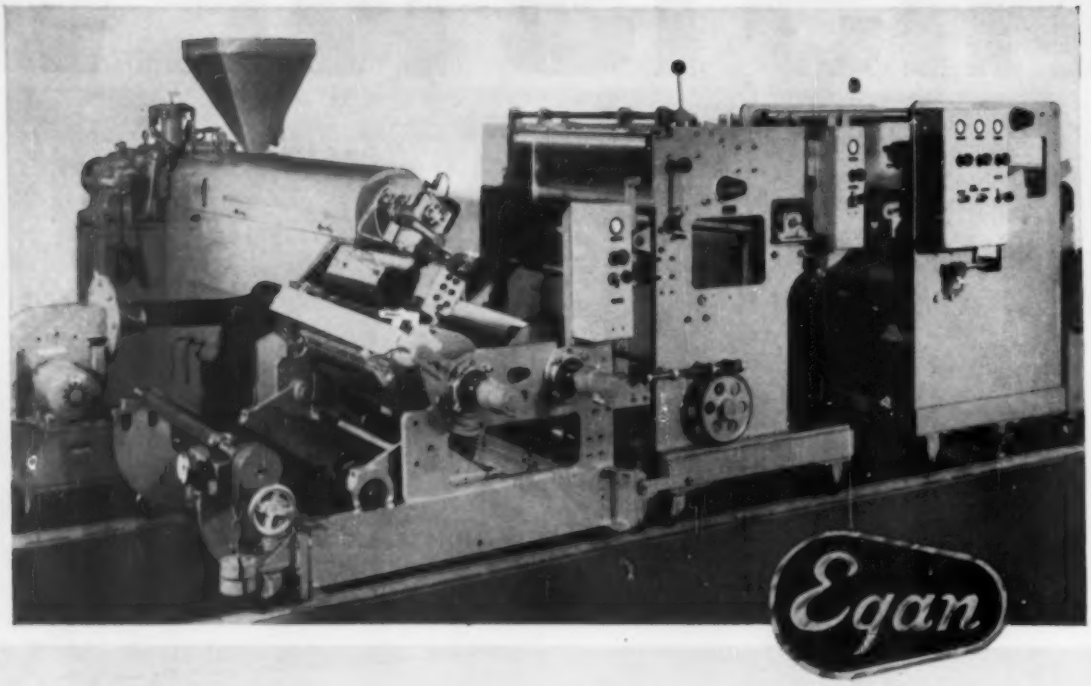

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Egan Extruders are available in sizes from 2″ through 12″, vented or non-vented, with L/D ratios of 20:1, 24:1, 32:1.

The laboratory film extrusion installation pictured above features an Egan Air Cooled Extruder, as well as Egan accessory equipment. In an application such as this, excessive frictional heat is not too prevalent. Therefore, the temperature control system included on an Egan Air Cooled Extruder is sufficient to remove whatever excessive heat may develop.* The air cooling system is also helpful at time of "shut-down," since it is possible to cool the barrel more quickly. This minimizes the possibility of degrading any material remaining in the cylinder.

Installations, such as the one above, are suitable for cast film, water quenched film and extrusion coating.

Production size units are available with Egan Extruders from 2″ through 12″ and die and take-off equipment through 120″.

*Where excessive frictional heat is a problem, the Egan Extruder with the Willert Temperature Control System is recommended.

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NEW DEVELOPMENTS

Many minds at work on new ways to use plastics, new designs, and new product concepts offer ideas you can use.

Polycarbonate for soldering iron

Further evidence that polycarbonate applications are not limited to industrial markets is offered by the recently introduced Imperial soldering iron. This consumer item uses an injection-molded polycarbonate handle.

The iron is designed for interchangeability of components, so that the same handle and cord set can be used for a wide range of wattages and soldering tips. Interchangeability requires a high degree of dimensional stability—even under the high heats encountered in soldering—since the electrical connections of the iron must function with whatever parts are being used.

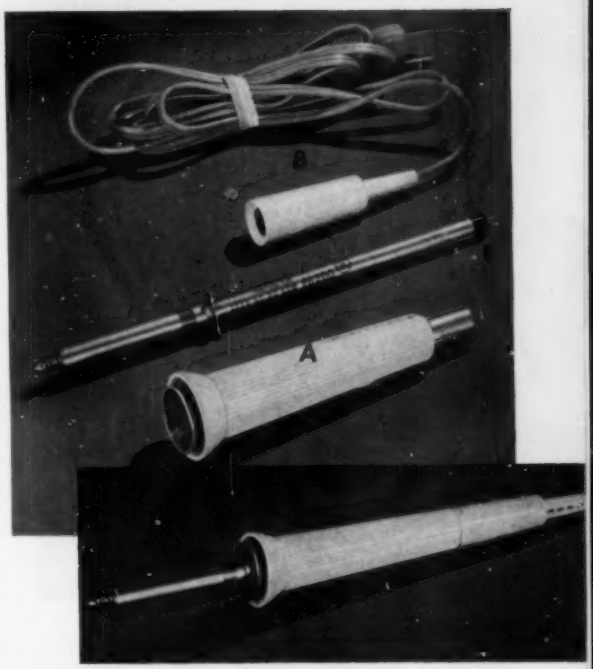
Polycarbonates, which show a lineal change in dimension of 0 after 30 min. at 212°F. (ASTM D-1204 test), were thus exceptionally well suited for this application. In addition, they offer a spectrum of attractive pastel colors.

The handle is produced in an eight-cavity mold, ring-gated at the flared end with a flat tab-gate. Cycle is 100 shots per hour. Weight of the handle is ½ oz., and length about 4.5 inches. When assembled for use, the handle is separated from the heater cartridge by an air space surrounding a die-cast aluminum insert through which the cartridge runs. This construction is said to keep the handle cool to the touch even after hours of continuous usage. The molded-in flare end minimizes accidental contact with the hot cartridge element.

In addition to the polycarbonate handle, the iron also incorporates a plasticized vinyl cord and cord connector (injection molded in a two-cavity mold), and a phenolic locating seal, automatically compression molded in an eight-cavity mold.

Retail price for the handle with aluminum insert is $1.28. The cord set shown in the illustration is also $1.28. Grounded three-wire cord sets, which are available, are priced higher.

Soldering iron produced by Ungar Electric Tools, Hawthorne, Calif. Lexan polycarbonate supplied by General Electric Co.



SLEEK SOLDERING IRON features polycarbonate handle (a), vinyl cord and cord connector (b) and phenolic seal (c).

Tiny acrylic sharpeners for eye and lip pencils

Thanks to precisely-molded parts of high-impact acrylic, a new line of eye and lip pencils can be kept constantly sharp and ready for use.

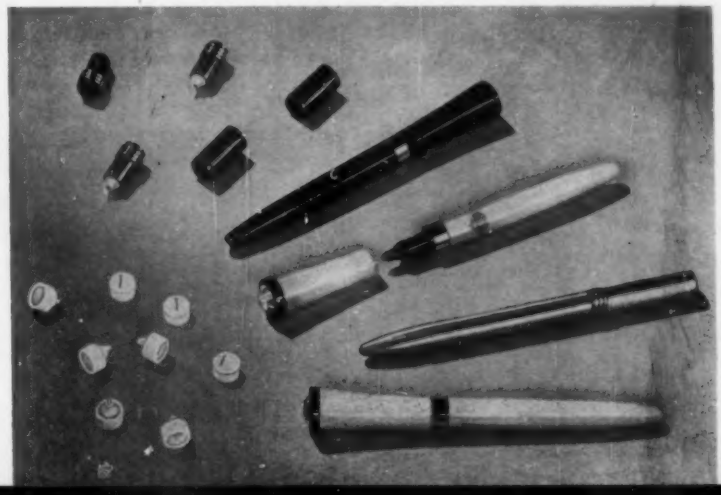
The acrylic parts are tiny sharpener heads, which are fitted into the upper halves of the pencil caps. By applying slight pressure on the cap and rotating the pencil a few times, the user can shave down the tip of the pencil to the desired point.

According to the manufacturer, Spatz Laboratories, Santa Monica, Calif., the choice of acrylic was based on the accurate molding possible with this material and the dimensional stability it provides in molded parts. In addition to this advantage the acrylic imparts toughness and resistance to breakage of the thin-walled parts, and is resistant to staining from the eye and lip cosmetics.

The small parts, which have a base diameter of ¼ in., stand ⅜ in. high, and weigh just a fraction of an ounce, are injection-molded by Spatz, using 16-cavity molds so precisely engineered that the sharpeners are ready for use right after they are cut from the sprue. Core pins are accurately adjusted to insure geometrically perfect mating when the two mold halves are closed. Molding material is Implex, a product of Rohm & Haas Co.

(More on page 180)

TINY CONICAL PARTS (lower left) are designed to sharpen tips of eye and lip pencils at right. Injection molded of acrylic, sharpeners are fitted into barrel housings, then assembled into pencil caps.



POURING FORMS of reinforced plastic are installed in place with broad-headed nails. One nail anchors corner of four pans.

CONCRETE is poured over RP forms after reinforcing strips have been laid in place. Pans are good for seven or more pours.

Better results at lower cost with RP concrete pouring forms

Concrete forming pans of molded glass-reinforced polyester have replaced standard steel domes traditionally used for concrete pouring and have brought:

- 15% saving in initial cost.
- Reduction in stripping time to 5 sec./sq. ft.
- Smoothness to exposed concrete grid ceilings that obviates costly and time-consuming finishing prior to painting.

The RP pans are being used in the construction of a five-building residence hall project at Pennsylvania State University.

A total of 6000 pans were purchased for this job, involving an initial outlay of $35,520. Use of steel domes would have involved a rental fee of $1 per pan per pour. The plastic pans, conservatively estimated to be good for 7 pours (actually such pans have been used for as many as 25 pours), represent a total of 42,000 pours. On this conservative basis alone, they can chalk up initial savings of $6480.

The pans weigh 6¾ lb. each, which is almost 10 lb. less than their steel counterparts and results in substantial savings in shipping and handling costs.

According to the contractor, Virginia Engineering Co., cost for setting, stripping, and cleaning where necessary, and moving the pans to the next floor is less than 6¢ per sq. foot. Since no steel pans are used on this project, no exact figure on this particular cost with steel pans is available, but it would be substantially higher.

The pans are molded in matched metal dies by Molded Fiber Glass Co., Ashtabula, Ohio, using a 10-mil surface veil to assure a smooth casting. The pans have outside dimensions of 24 by 24 in., a void of 19 by 19 by 8 in., and a wall thickness of 0.110 inch. Work is reportedly underway on additional sizes with voids of 30 by 30 by 12 in. and 30 by 30 by 14 inches.

The new pans come ready to use. They are held in place by broad-headed nails at each corner (a single nail anchors the corner of four pans.

Unlike metal forms, the plastic pans will not dent. Should they break (on the particular job, the contractor reported only five pans damaged by the accidental dropping of bundles of reinforcing steel) they are easily patched and returned to their original state.

Dishwasher parts of PP meet severe in-use conditions

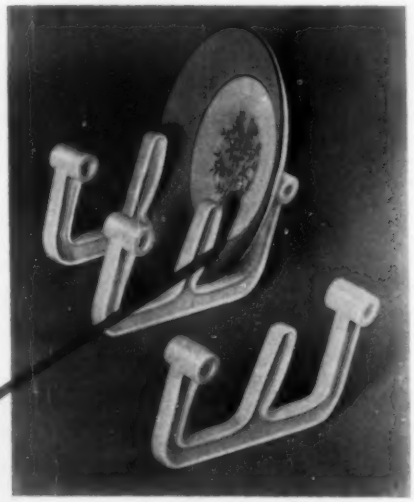
The high degree of chemical resistance and mechanical stability of polypropylene at elevated temperatures have made it a logical choice for dish "cradles" in the conveyor belt of a new institutional dishwasher.

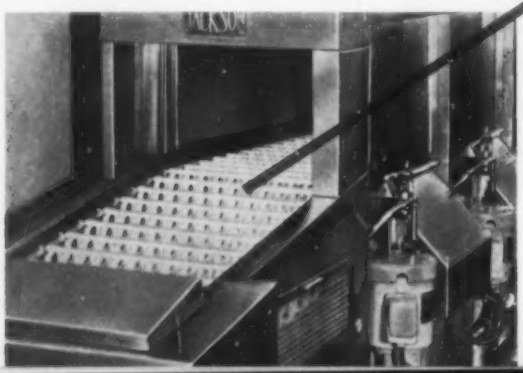
The polypropylene cradles are required to stand up under service temperatures of up to 190°F. under heavy loads of dishware, which pass through the washer at the rate of 13,000 per hour.

Materials previously used for the conveyor belt racks, including plastic-coated steel, were limited either by their inability to withstand the detergent chemicals or their tendency to swell from hot water contact.

More than 1000 of the 4-in. cradles are interlocked to form the conveyor belt. According to the manufacturer, Jackson Products Co., Tampa, Fla., polypropylene's use permitted a re-design of the rack part so that their number in the conveyor belt could be reduced by one-third.

The PP units are injection-molded by Pearce Simpson Inc., Molded Plastics Div., Miami, Fla., which uses Enjay's Escon polypropylene.





MOLDED PP DISH "cradles" make up conveyor belt of new dishwashing machine, will withstand detergent chemical attack and heavy mechanical loading. Over 1000 of these parts are incorporated in dishwasher unit shown at left.

Invisible indoor aerial

The unsightly "rabbit ears" indoor TV antenna may soon become a thing of the past, thanks to a newly developed aerial of ver circuitry on flexible vinyl film that can easily be installed in a number of out-of-sight locations.

The new antenna is shaped like two butterfly wings, 5 ft. across. The user can install the antenna by thumb tacks to such areas as furniture backs, attic walls, behind draperies, and even under a rug. And the flexible antenna, even with its connecting lead, can be rolled into a ¼-lb. package 1 ft. in length by 1½ in. in diameter.

Vinyl film was chosen for this application because it provided low dielectric loss for maximum efficiency, in addition to being flexible and low in bulk. The clear film has a matte surface to permit maximum deposition of silver on the film while minimizing the chances of flaking or cracking of the silver deposit.

The product is made by RF Industries Inc., Summit, N. J., a company newly established by Frank Higgins, inventor of the antenna. Known as the Mite-Site, the antenna will soon be distributed nationally, and is expected to retail for approximately $3. Koroseal vinyl film used in the fabrication of the antenna is supplied by B. F. Goodrich Industrial Products Co., Akron, Ohio.

Now—blown bottles for milk

The newest material for milk bottles is high-density polyethylene, and a gallon-capacity container blow molded from this material is said to be 47% lighter and about 40% less expensive per unit than a glass container.

Designed for use as a family-sized consumer package for milk, the new bottle is marketed by Plastics Div., Hydrocarbon Chemicals Inc., Keyport, N. J.

Initial cost to the dairy for the new bottle has been estimated at about 15¢ apiece, compared with 23¢ per unit for a glass milk container. In addition, it is estimated that the PE container will have an average life of 25 round trips, whereas 11 round trips are an average for glass milk bottles.

Other desirable features of the PE milk container are its modified-square shape which takes up one-third less shelf space than glass bottles, its ability to be sterilized in existing equipment, and the fact that it will not impart an odor to the milk.

The polyethylene bottle is blow molded by Hydrocarbon Chemicals using blowing equipment of its own design and manufacture. Resins are supplied by W. R. Grace & Co., and by Phillips Chemical Co.

CONTAINER BLOW MOLDED from high-density polyethylene is now being tested as a gallon-sized milk package, designed to replace glass bottles at 47% less weight and 40% less cost. Notice handle (standard item supplied by Sun Industries), which snap-fits around neck of bottle.

Polystyrene build-it-yourself camera

From a $10 kit containing component parts, 18 of which are injection-molded of high-heat, high-impact polystyrene, amateur photographers can assemble a real working camera and learn photographic principles in the process.

When the camera is assembled, it measures 5 in. long, 2¾ in. wide, and 6¾ in. high. Complete weight is 6.25 oz., of which 4.55 oz. are plastics weight. The plastic parts range from major pieces, such as the housing, flashgun body, and lens cover, to such smaller parts as the film winding knob and the flashbulb ejector clip.

The camera kit is marketed by Eldon Industries Inc., Toy Div., Hawthorne, Calif., which also molds the polystyrene components in an 18-cavity mold on a 12-oz. Improved Machinery Inc. injection molding machine. Polystyrene molding material is supplied by Dow Chemical Co. Several of the camera's housing parts are vacuum metallized in order to provide a contrasting trim on the completely-assembled camera, and the flash reflector is also vacuum metallized to a bright finish, as shown in the photograph at right.

(More on page 182)

WORKING CAMERA, suitable for black and white or color photography, is assembled from many components, including 18 molded PS parts.

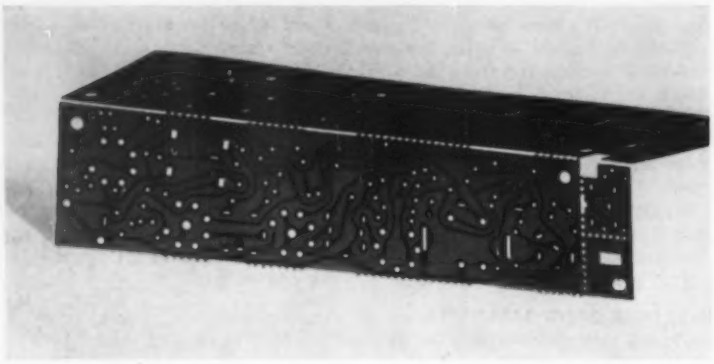
Polyethylene switch box protectors

Plaster guards molded of polyethylene provide a simple and effective way to protect electrical outlets during plastering and serve as locators for the boxes after the job is done. The device seals off outlet apertures. Prongs on one side of the guard fit snugly into switch mounting holes, keeping them free from plaster and making retapping unnecessary. Problems of skinned wires and short circuits, a frequent result of scraping plaster from box interiors, are eliminated. A pointer projecting from the other side permits easy removal of the guard once the plastering job is completed. Eight models are currently being produced and are designed to fit most any type and size of outlet box.

Credits: Manufactured by C.F.C. Corp., North Hollywood, Calif., using Tenite polyethylene supplied by Eastman Chemical Products Inc.

PE OUTLET GUARDS, rectangular for double outlets, circular for single. Molded-in prongs insert into outlets to hold guards in place.

New laminate for printed circuits



Priced about the same as XXXP paper-base copper-clad laminate, but exceeding it in several important properties, a new glass-reinforced ester-type polymer board is now offered to the printed circuit industry. Previously, only two types of circuit board were available: paper-base phenolic and glass-reinforced epoxy. Introduction of the new laminate now provides the manufacturer with a competitively priced material to fill the big property gap between the former two laminations. Glass epoxy laminates are about three times as expensive as paper-base phenolic boards.

Below are some typical property comparisons furnished by the manufacturer of the new board.

Impact strength (ft.-lb./in. of notch; the higher the figure, the stronger):

Paper based:	0.8
New laminate:	10
Glass epoxy:	15

Flexural strength, p.s.i. (the higher the figure, the more difficult it is to break the sample by bending):

Paper based:	15,000
New laminate:	23,000
Glass epoxy:	50,000

Coefficient of thermal expansion (in./in. °C. × 10^5; the higher the figure, the more the material expands under heat):

Paper base:	4.0
New laminate:	2.1
Glass epoxy:	1.1

In addition, the electrical properties are said to be very good, and the material is rated as self-extinguishing. Heat distortion point is 230° C.

The new laminate consists of a modified ester-type polymer system, non-woven glass fiber reinforcement, and copper sheet, laminated together so as to provide a peel strength as high as 12 lb. per inch of copper. Cimclad printed circuit board by Cimastra Div., The Cincinnati Milling Machine Co., Cincinnati, Ohio.

Impact acrylic patty maker

Impact acrylic hamburger patty maker, which forms ground meat into circular cakes of uniform size, consists of three parts: the top and base sections, hinged at one end, and a perforated circular disk, which rests atop a coiled wire spring inside a recess in the base. Projecting up from the recessed base are molded-in perforating pins which can be matched up with the perforations in the disk to pierce small holes into the patty to facilitate cooking.

Impact acrylic was selected because of its resistance to breakage, freedom from odor or taste, and resistance to staining, and ease of cleaning.

The patty maker components are injection molded by 20th Century Products, Detroit, Mich., which also markets the unit. Implex high-impact acrylic is supplied by Rohm & Haas.

Butyrate men

Two synthetic men, with skin and vital organs made of transparent butyrate, are helping science to gauge the effect of radiation on the human body and to perfect techniques for controlling its use in biological uses.

Body shells and other parts are vacuum formed from optically clear butyrate sheet. These parts permit unobstructed penetration of X-rays, gamma rays, and neutrons, and they possess a high degree of stability under prolonged radiation.

One of the butyrate men is constructed of 34 individual plastic parts, and also contains plastic counterparts of the thyroid, liver, lungs, kidneys, spleen, and other organs.

The figures are made by Alderson Research Laboratories Inc., Long Island City, N.Y., and are priced at $2,665 for body shell complete with organs or $3,550 with skeleton. Vacuum forming is done by Alda Plastics Inc., New York, N.Y., using Tenite (Eastman Chemical) butyrate sheet.

(More on page 187)

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* MIRACLE SURFACE—REG TMK RADIO CORPORATION OF AMERICA

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MANAGEMENT: International Exposition Company, 480 Lexington Ave., N. Y. 17, N. Y.

PP "trap door" for transistor radio

The self-hinging properties of polypropylene have moved into another important application area with the introduction by Motorola Inc., Chicago, Ill., of a pocket portable radio whose injection-molded polypropylene case back incorporates an integrally molded "trap door" type battery compartment cover. Comprising most of the entire case area, the back is used in conjunction with a gold-finished zinc die-cast front section.

This unique feature of the Model X-27, a seven-transistor set, eliminates the customary inconvenience of removing the complete back of the set for battery replacement. Inconspicuously designed into the part, the hinge is adjacent to a louvred opening centered in the back of the set. This construction (see lower photo) effectively camouflages the ridge or bead characteristic of an integrally molded plastic hinge.

The hinged access panel includes a concealed catch centered at the free end and smaller positioning lugs at the corners which insure a tight closure and accurate alignment when it is snapped closed.

The entire back, optionally available in either black or white, is molded with a simulated leather surface which minimizes scuffing and upgrades the appearance of the set.

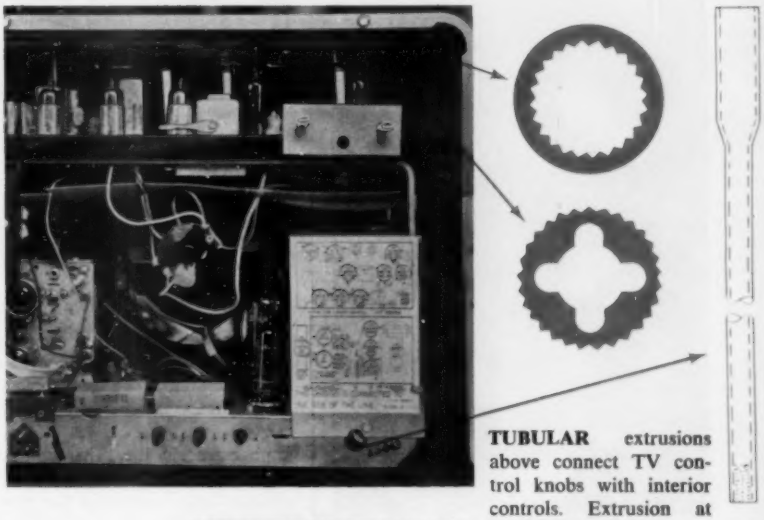
Credits: Component molded by Sinko Mfg. & Tool Co., Chicago, using AviSun polypropylene.

Product design with custom extrusions

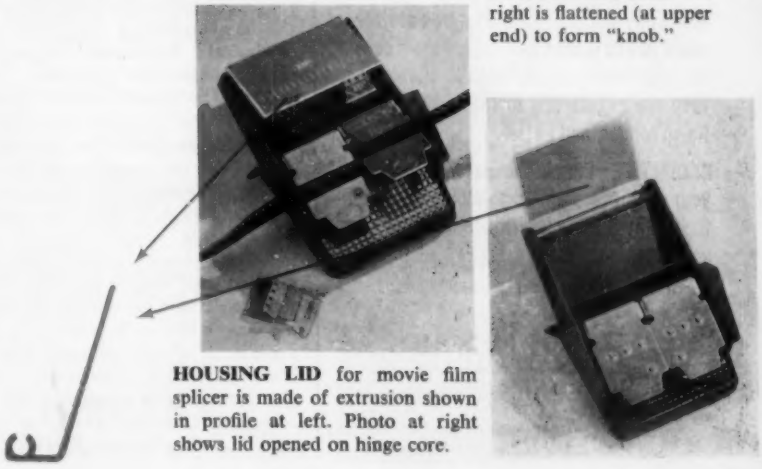
Because of the relatively low tooling costs involved, custom extrusions frequently present an economic solution to a product design problem—provided the designer is alert to the potential of extruded profiles. The three case histories described below illustrate this point for a diverse group of industries. The extrusions were supplied by Anchor Plastics Co. Inc., Long Island City, N.Y.

Control shafts: It is usually more economical for a manufacturer of electronic equipment to buy standard variable controls with standard-length tuning shafts. However, it is not always possible to locate controls close to the outside housing; and, in those cases, it becomes more economical to connect the control knob with the control by means of an extruded tubing containing integral internal and/or external flutes to fit into or over the control shaft or knob. Three such extensions are shown in the upper part of the television chassis pictured in the accompanying photograph. These were extruded of high-density polyethylene and incorporate internal flutings. Extruded nylon has also been used for this application. In the diagram shown, both internal and external fluting is provided to make the extension fit both into the control knob and over the control shaft. In the lower right hand corner of the TV chassis is another nylon extrusion. This tubing is heat-sealed at one end to provide a knob-type action, and threaded at the other to go over the threaded stud of the variable control.

Housing lids: Econo- **(To page 188)**



TUBULAR extrusions above connect TV control knobs with interior controls. Extrusion at right is flattened (at upper end) to form "knob."



HOUSING LID for movie film splicer is made of extrusion shown in profile at left. Photo at right shows lid opened on hinge core.

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ZITHER-LIKE musical instrument uses high-impact extrusion shown in profile at left to form edge of housing. L-shaped center flange was substituted for solid block to hold down material usage.

mies made possible through low-cost extrusion dies (as against more expensive molds) are brought home in a line of covers for the HP series of movie-film splicers. These splicers use a high-impact polystyrene profile as the lid for the splicing-tape compartment at the top of the unit. Two integrally cast pins in the splicer body snap into the circular part of the extrusion and thus provide hinging action. The significant aspect of this particular job is that, simply by changing cutting lengths, covers for a whole range of models can be produced . . . all from the same extrusion die. This same technique has been used to produce radio cabinets and is suitable for a whole range of applications where length is the only variable.

Musical instrument: Significant, though unspecified economies, were obtained by Oscar Schmidt International, Jersey City, N. J., in switching from machined wood to high-impact polystyrene for a molding at the bottom of the Autoharp, a zither-type instrument. By redesigning the original wood profile, important weight savings were obtained: wall thicknesses were reduced, and an L-shaped flange substituted for a solid block, to retain the same width at the center leg with a minimum of material usage. The finished extrusion is lacquered to a high gloss, currently in vogue on a number of musical instruments.

(More on page 191)

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PORTLAND, OREGON	Capitol 3-4197
RICHMOND, VIRGINIA	ATlantic 8-8758
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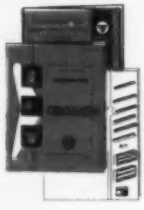

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RP totem pole display

A 16½-ft. totem pole, constructed of glass-reinforced polyester for strength and outdoor weatherability, is designed to call attention to roadside establishments, particularly parks built around Indian or Western themes.

The RP totem is an authentic design, yet its price of $850 is said to be less than one-third that of a hand-carved pole. Twelve representative faces appear on both sides of the 28-in. diameter pole, including a symbolic bird with 6-ft. wingspread. The pole is built to withstand winds up to 75 m.p.h., and is hand-painted in weather-resistant blue, red, white, yellow, brown, and black colors.

The totem pole is produced by hand layup in eight sections, and joined together by bonding and bolting. The units are molded by Monomold Corp., N. Tonawanda, N.Y., for House of Bronze, Grand Island, N.Y. Polyester resin supplied by Reichhold Chemical Co., glass reinforcement by J. P. Stevens & Co., Inc.

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Clear extruded tubes of acrylic have been found to be effective in shielding valuable documents and art treasures from the damaging effects of ultra-violet light emitted by fluorescent lamps. The material used is a special grade of ultra-violet-absorbent methacrylate.

Installation of the new tubes requires no change in the existing light fixtures. The fluorescent lamps are simply removed from their sockets, the plastic tubes are slipped over them, and the lamps re-inserted.

First users are the Smithsonian Institution and the Bureau of Archives, Washington, D. C.

The tubes are extruded by Westlake Plastics Co., Lenni, Pa. Plexiglas acrylic supplied by Rohm & Haas Co., Philadelphia, Pa.

. . . And in brief

● Keg-tapping equipment made of B. F. Goodrich Geon vinyl makes easier use of draught beer for picnics and home barbecues. The equipment, manufactured by Pure Dispenser Corp., Cleveland, Ohio, consists of an adapter on the keg, a tapping tube which is inserted through the adapter into the keg, and a spigot assembly. Withdrawal of the tube reseals the keg for storage.

● A canteen weighing only 3½ oz. in 1½-qt. size is made of Phillips Marlex high-density polyethylene by M. E. Shaw and Sons, Los Angeles, Calif. Canteen, retailing at $2.39, imparts no taste to beverages.—**End**

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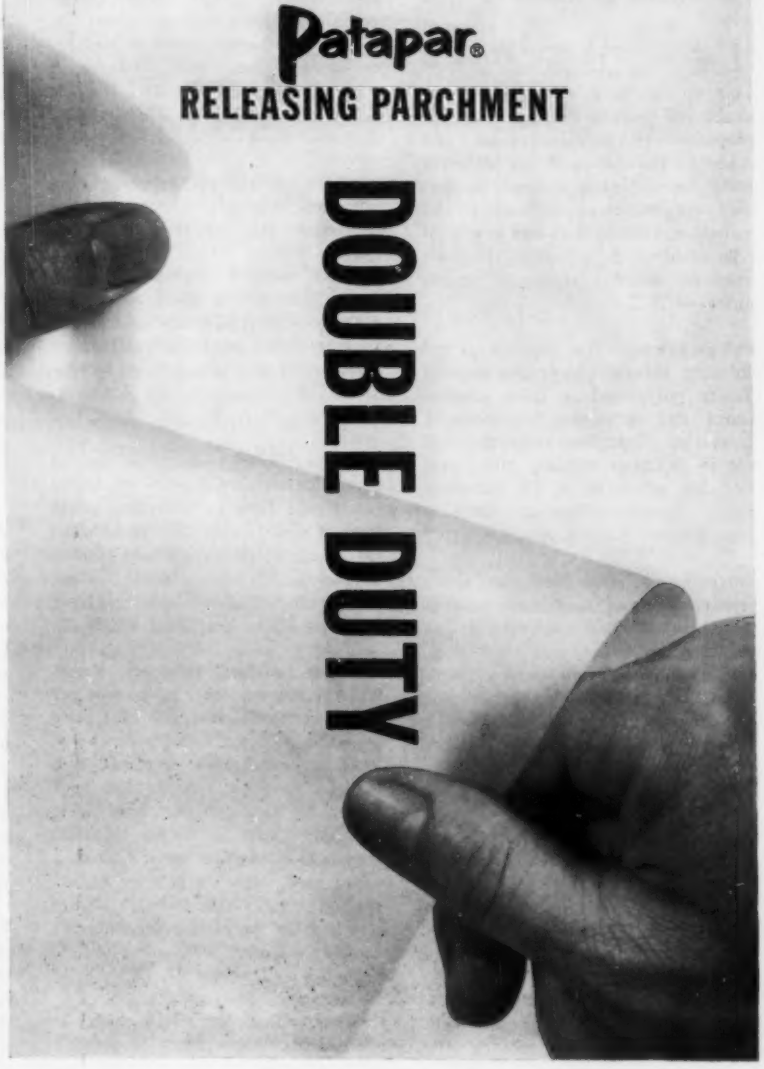

LITERATURE

Write for these publications to the companies listed. Unless otherwise specified, they will be sent gratis to executives who request them on business stationery.

"High Speed Testing—Volume II," *Edited by A. G. H. Dietz and F. R. Eirich.*

Published in 1961 by Interscience Publishers Inc., 250 Fifth Ave., New York 1, N. Y. 75 pages. Price: $4.50.

This book is a bound collection of eight papers on the subject of high-speed testing of polymers, presented at the 2nd Annual Symposium on the subject at Boston, Mass. on Jan. 27, 1960. Editors of the book were co-chairmen of the symposium. The book will be of major interest to rheologists and advanced design engineers working in the field of testing polymeric materials.—*G.R.S.*

"Resins-Rubbers—Plastic Yearbook 1960," *Edited by Norman G. Gaylord.*

Published in 1960 by Interscience Publishers Inc., 250 Fifth Ave., New York 1, N. Y. 1567 pages. Price: $60.00.

This volume is a collection of abstracts of papers dealing with the properties of plastics, resins, and rubbers. The abstracts are different from the ordinary abstract in that they are more comprehensive and include significant data and graphical relationships. A valuable reference work for polymer chemistry laboratories.—*G.R.S.*

Polypropylene. The advantages of coloring natural polypropylene with Tenite polypropylene color concentrates, and techniques for achieving coloration dispersions through their use in injection molding and extrusion are set forth in TR No. 4. 4 pages. *Eastman Chemical Products Inc., Kingsport, Tenn.*

Polycarbonate films. Properties, applications, effects of moisture, permeability, chemical resistance, optical and electrical properties, and other technical data on Lexan polycarbonate films. Compares extruded and solvent cast films. Bulletin CDC-396. 13 pages. *General Electric Co., Chemical Materials Dept., 1 Plastics Ave., Pittsfield, Mass.*

Polyester and acrylic-modified polyester resins. Physical and chemical properties for the following resins, including suggested formulations for various types of applications: Paraplex P-13, a light amber solution consisting of 50% polyester and 50% styrene monomer, Bulletin 451, 4 pages; Paraplex P-49, an unsaturated polyester dissolved in monomeric styrene, Bulletin 420, 8 pages; Paraplex P-444A, a polyester resin, Bulletin 392, 12 pages; Paraplex P-446A, a 3-component system containing an unsaturated polyester, methyl methacrylate monomer, and styrene monomer, Bulletin 364, 4 pages; Paraplex P-47, an unsaturated polyester in styrene monomer, Bulletin 450, 8 pages; and Paraplex P-43 and Paraplex P-43HV, unsaturated polyesters dissolved in styrene monomers, Bulletin 442, 8 pages. *Rohm & Haas Co., Washington Square, Philadelphia 5, Pa.*

Catalyst. Specifications, properties, applications, packing and shipping data, etc., for Lupersol Delta-X, a colorless solution of methyl ethyl ketone peroxides and hydroperoxides in dimethyl phthalate, which is used for curing polyester resins. Data Sheet 4.303. 5 pages. *Lucidol Div., Wallace & Tiernan Inc., 1740 Military Rd., Buffalo 5, N. Y.*

Additive for plastics. Properties, applications, test data, toxicological information, etc., for Demivis, a calcium sulfonate, which is used as a plastisol viscosity depressant, a pigment dispersant in plastisols, a dispersant in premixing operations, and in vinyl foam production. 10 pages. *Continental Oil Co., Petrochemical Dept., 1270 Avenue of the Americas, New York 20, N. Y.*

Overlays. Bulletin describes use of protective overlay fabrics of Dynel modacrylic fiber to overcome problems of wear, weathering, and chemical attack on glass-reinforced plastics laminates. 8 pages. *Union Carbide Chemicals Co., Textile Fibers Dept., 270 Park Ave., New York 17, N. Y.*

Injection molders' reference charts. Chart 1 gives number of pounds per 1000 pcs. based on weight of 1 piece in grams. Chart 2 lists conversion of grams into ounces at a glance, also includes data on how to determine present heating cylinders plasticizing capacity. Chart 3 is an electrical amperage conversion table. Charts, 2 pages each, measure 8½ by 11 in., are on card stock and are center punched for easy hanging. *Injection Molders Supply Co. Inc., 17601 S. Miles Rd., Cleveland 28, Ohio.*

Coating calculator. Slide-chart is available to web coaters to provide immediate answers to coating problems: how many reams are produced per hour; total dry coat weight applied per hour; total wet coat weight applied per hour for any percent solids; lb./hr. solvent or water which has to be evaporated; etc. *Waldron-Hartig Div., Midland-Ross Corp., Box 791, New Brunswick, N. J.*

Glossary of organic chemicals. Glossary includes 483 organic chemicals marketed by the company, including code number, tradename, Chemical Abstracts name, and commonly-used name. 11 pages. *National Aniline Div., Allied Chemical Corp., 40 Rector St., New York 6, N. Y.*

Plasticizers. Specifications, physical properties, typical performance in vinyl films, etc., for Morflex diisooctyl adipate, acetyl tri-*n*-octyl/decyl citrate, and ditridecyl phthalate plasticizers. Data Sheet 560. 9 pages. *Chas. Pfizer & Co. Inc., 235 E. 42nd St., New York 17, N. Y.*

Fibrous glass reinforcements. "Fiberglas Materials for Matched-Die Molding" contains descriptions of the four basic Fiberglas non-woven reinforcements—spun strand roving and continuous strand roving, chopped strand mats, and continuous strand mats — and discusses the basic matched-die molding processes—preform, premix, and mat molding. 16 pages. *Owens-Corning Fiberglas Corp., 717 Fifth Ave., New York 22. N. Y.*

Plastics tradenames. "Tradenames of Rubbers, Resins, and Plastics" is a comprehensive listing of world-wide tradenames, including a description of the product and its manufacturer. First volume, issued in 1949, covered registrations from 1926-1949; second list, issued in 1955, covered 1949-1954; third volume, issued in 1961, includes 1955 to 1959. Price of third volume in U. S. currency is $10, or, with second issue, $15. First volume is out-of-print. 242 pages. *Rubber and Plastics Research Assn. of Great Britain, Shawbury, Shrewsbury, Shropshire, England.*

This Is Cary Chemicals describes the products and services available from this producer of polyvinyl chloride homopolymers, copolymers, etc. 4 pages. *Cary Chemicals Inc., P. O. Box 38, E. Brunswick, N. J.*—**End**

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THE NEW STABILIZING PLASTICIZER WITH 9% OXIRANE OXYGEN

If you are caught in the conflict between resin compatibility and heat stability that exists with ordinary epoxidized oils—if adding enough plasticizer to achieve the desired heat stability leads to spewing—if reducing the plasticizer enough to end spewing leads to poor heat stability—try high purity Swift's Epoxol 9-5.

Where previous advances in oxirane were in fractions of a percent, now in one jump, Epoxol 9-5 approaches the theoretical limit for epoxidized oils. Epoxol 9-5 opens a whole new frontier in vinyl technology by permitting the use of concentrations that were previously impractical.

The specifications at the right show other advantages, too: low viscosity indicates low polymer . . . low infra red absorption shows low hydroxyl content . . . iodine value is minimum, consistent with low by-products . . . odor is low, as well.

Your own tests are the only way to prove that Epoxol 9-5 will provide the compatibility *and* heat stability you need for tough jobs. Return the coupon, below, for full details.

SPECIFICATIONS
EPOXOL 9-5

Oxirane Oxygen	9% Min.
Iodine Value	5 Max.
Gardner Color	Less than 1
Gardner Viscosity @ 25°C	V Max. (8.8 poises)
Saponification No.	176 Max.
Acid No.	0.3 Max.
Absorptivity 2.9 Microns (Corrected for Background)	0.020 Max.
Specific Gravity 25°C/25°C	1.020 ± .007

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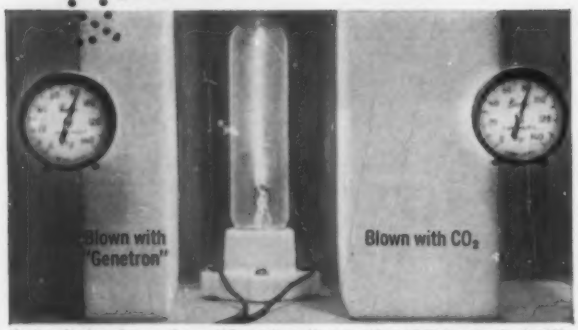

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Plus many other advantages: Foams blown with "Genetron" fluorocarbon gases rise at lower temperatures, permit larger forms. They're easier to control – "Genetron" does not react with other constituents. They cure rapidly, even at room temperature . . . and they're safer. "Genetron" -blown foamed-in-place urethanes have all the structural advantages of ordinary urethanes!

Write for our comprehensive technical bulletins, "Genetron Blowing Agents for Rigid Urethane Foam," and "Determining Genetron Content of Rigid Urethane Foam."

Other major components of the urethane foam system produced by Allied Chemical: polyethers and Nacconate® diisocyanates by National Aniline Division; resins by Plastics Division.

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

New machinery-equipment

(*From pp. 52-60*)

to handle a wide range of viscosities at ambient or controlled temperatures. The unit will also handle resins with ultra-short pot life (down to 8 to 10 sec.) without freeze-up or clean-up. Typical production rate is 120 intermittent shots/min. or a continuous stream of mixed resin. Polished metal-to-Teflon bearings and seals minimize wear and simplify maintenance. Positive internal air pressure throughout system prevents entry of contamination. *Mitchell Specialty Div., Novo Industrial Corp., Edmund and Shelmire Sts., Philadelphia 36, Pa.*

Vacuum former

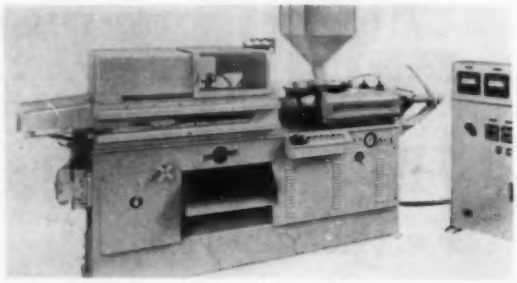
The Tronomatic 2436 machine is designed for roll feed and rapid production. Areas of sheet up to 24 by 36 in. can be formed into plastic parts at a rate of 3 to 6 cycles per minute. The unit is a 6-in. updrape type with diffused zone heating; the heater has 21 rods and is of high but safe watt density. Roll widths from 12 to 36 in. may be handled. The adjustable clamp frame can be varied in size in 1-in. increments from 12 by 12 to 24 by 36 inches. Accessory equipment includes an automatic cutter, temperature-controlled table, automatic roll unwinder, partial vacuum or air billow timer, controls, and a plug attachment. Model VF-2436, including automatic roll feed, material take-off rack, vacuum tank, and motor, is priced at $7600 f.o.b. mfr. Optional accessories are available at added cost. *Tronomatic Machine Mfg. Corp., 25 Bruckner Blvd., Bronx 54, N. Y.*

Bending equipment for laminates

Designated SRS 12 and SRS 6 (12- and 6-ft. models, respectively), this equipment is designed for the fabrication of standard-grade Formica laminates for coved applications. Designed for portability, the equipment consists of a table and thermostatically regulated postforming increment heaters. Inside bends on sheets can be made for such applications as full backsplash sink tops and one-piece shower enclosures. Price: $550 and $350, f.o.b. mfr. *SRS Products Corp., P. O. Box 12086, Houston 17, Texas.*

Injection machines

Three new models of Standard Automolders are now being offered: models K2-50-50, K2-100-50, and K3-100-50. The first K2- models are similar, K2-100-50 being slightly larger in size, and having a larger plunger diameter (1.75 vs. 1.5 in.), higher clamping capacity (100 vs. 50 tons), a longer clamp stroke (9 vs. 6 in.), and a larger motor (20 vs. 10 h.p.). Both have rated shot capacities of 2 oz., a plasticating capacity of 30 or 40 lb./hr., a plunger stroke of 5 in., heater powers of 3.15 to 4.5 to 4.9 kw., and will handle molds 9 in. wide by 12 in. high with injection pressures up to 14,200 p.s.i. on the material. The K3-100-50 is similar to the K2-100-50, but has a shot capacity of 3 oz., a plasticating capacity of 45 lb./hr. and an injection



plunger stroke of 6 inches. It will handle molds 12 in. wide by 15 in. high at injection pressures up to 20,000 p.s.i. using a plunger of 1.5-in. diameter. Dry cycles are rated at 1500/hr. vs. 2000/hr. for the other two models. *Standard Tool Co., Leominster, Mass.*

Injection machine

The Impco MA225 Series of injection machines offers the molder a choice of injection systems. Models MA225-R16 and MA225-R32 are equipped with reciprocating-screw cylinders of 0- to 16-oz. and 0- to 32-cu.-in. shot capacity. Model MA225-F35 has a piggyback plasticating extruder which feeds a conventional ram cylinder. Injection pressure on all models, at 2000 p.s.i. oil pressure, is about 16,000 p.s.i., and the rate of injection is about 22.5 cu. in. per minute. Cycles up to 1200 shots/hr. are possible. Clamp force and stroke are adjustable from 0 to 225 tons and from 6 to 16 in., respectively. Clamp daylight closed is adjustable from 5 to 20 inches. Minimum mold platen dimensions, between tie rods, horizontal and vertical, are 16¾ and 15¼ in.; over-all platen is 25¼ by 23¾ inches. Hydraulic knock-out stroke is adjustable to 3½ inches. *Improved Machinery Inc., Nashua, N. H.*

Casting rolls

For the production of extruded plastic film, the MPM Model WSF casting roll unit is available in 36-, 48-, and 60-in. width (trimmed) sizes. Casting rolls (double shell) are 13¾ in. in diameter; they can be furnished in diameters up to 16 inches. Normally two rolls with 4-in. shafts are supplied, but a third roll may be added at additional cost. Other driven rolls consist of two 6-in.-diameter water-cooled rolls and two Neoprene-covered rolls of the same diameter. Edge trimming is done with either driven rotary knives or razor blade slitters; trim scrap is removed by an integral blower system. A hot-knife cut-off system is included. Wind-up is of the turret type, and uses plug-type roll-core holders for cores with O.D. of 3½ inches. Maximum roll diameter is 20 inches. Overall standard speed range is 20 to 320 ft. per minute. Three 1½-hp. motors are used to power the unit. *Modern Plastic Machinery Corp., 64 Lakeview Ave., Clifton, N. J.*

Temperature controller

Complete transistorization of this on-off controller has resulted in a compact unit 3¾ in. high, 7$^{9}/_{16}$ in. wide, and 10 in. deep. It provides for continuous operation with no preventive maintenance. All ranges from 250° C. and 450° F. are available. Accuracy is 0.75% of full scale; 0.5% on special order. Sensitivity of control is ±0.5%. Type PRK1 is a one set-point instrument; Types PRK2 and PRK3 two set-points. *Curtiss-Wright Corp., Princeton Div., Box 110, Princeton, N. J.*

. . . Machinery in brief

▸ A new double-length piston rod end, style 2L, is now offered as an optional standard at no extra cost on Miller air and hydraulic cylinders by *Miller Fluid Power Div., Flick Reedy Corp., York Rd., Bensenville, Ill.*

▸ Closer temperature control is possible with this line of Digital Set-Point Controllers. An adjustable 3-digit, 1000-part dial allows the control point to be set in increments as small as 0.5°F. Sensitivity of better than 0.25°F. is possible when used with most thermocouples. *West Instrument Corp., 4363 West Montrose Ave., Chicago 41, Ill.*

▸ Developed for the precision drilling of small holes using unskilled labor, the Mico No. 905 drill press with pneumatically controlled spindle will hold drills from 0 to ⅛ in. in diameter. Two speeds are available. *Mico Instrument Co., 80 Trowbridge St., Cambridge 38 Mass.*—**End**

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Other major components of the urethane foam system produced by Allied Chemical: polyethers and Nacconate® diisocyanates by National Aniline Division; resins by Plastics Division.

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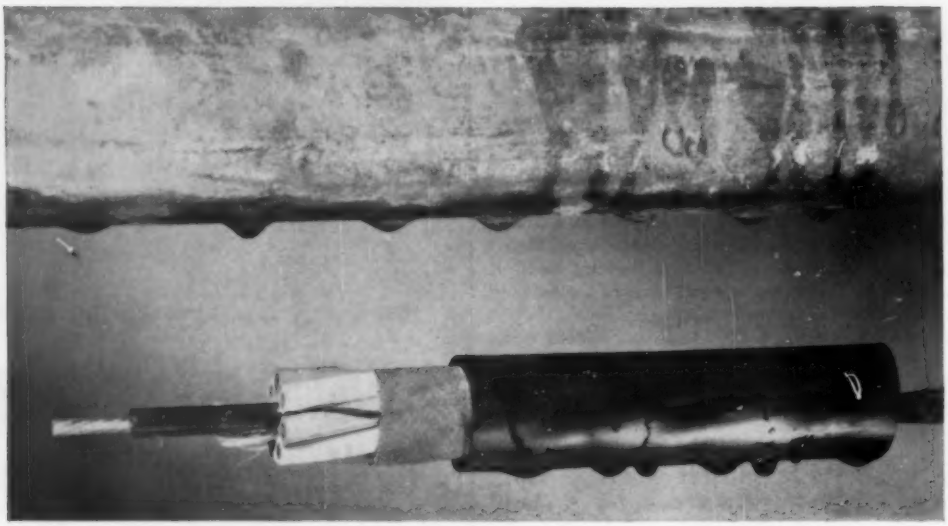

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Write for Bulletin or Consult CHEMICAL MATERIALS CATALOG, Pages 159-161

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Manufacturers' Literature

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EQUIPMENT • SUPPLIES • SERVICES

PLASTIC ADDITIVES. 16-page bound booklet summarizes technical and commercial information on line of plastic additives, including ultra-violet absorbers, antioxidants and antistatic agents. Booklet contains graphs, data. American Cyanamid Co. (101-I)

PLASTIC PRIMER. 12-page illustrated booklet gives top management facts on how and why they can utilize plastics in place of other existing materials. Gives comparison tables, basic facts, types and characteristics of plastics. Amos Molded Plastics. (102-I)

WIRING DIAGRAMS. 16-page manual punch-holed for binder gives schematic diagrams, explanations for eight 2-wire and twenty-five 3-wire control wiring diagrams for Arrow-Hart Motor Controls, single-phase and poly-phase. The Arrow-Hart & Hegeman Electric Co. (103-I)

METHYLPYRROLIDONE. 6-page booklet describes and discusses use of N-Methyl-2-Pyrrolidone which has a high solvent capacity and wide application. Acetylene Chemicals Dept., Antata Chemicals, Div. of Genetal Aniline & Film Corp. (104-I)

POWER PUNCH PRESS. Illustrated folder gives special features, specifications of the Allen 12-ton power punch press. Price list for press models and accessories. Alva Allen Industries. (105-I)

BLOW MOLD AND EXTRUDER MACHINES. Illustrated 10-page brochure describes Master-matic OM #8 for blowing hollow articles available with semi-automatic or manual cycling. Augusta Extruders, FM45 and FM60, are shown with dimensions and characteristics. ASCO MP. (106-I)

VINYL STABILIZER. Bulletin tells of new vinyl stabilizer, that reportedly reduces stabilizer costs more than 50%, serves to aid wetting fillers and as mold or calender lubricant. Allied Asphalt & Mineral Corp. (107-I)

MONIONICS. POLYMERS & POLYVINYL ALCOHOLS. 3-page insert fold-out describes and shows applications of surfynol, colton polymers and polyvinyl alcohols. Air Reduction Chemical & Carbide Co., Div. of Air Reduction Co., Inc. (108-I)

ELECTRONIC METAL DETECTOR. Illustrated folder describes electronic metal detector that is a completely automatic reject device that penetrates through a finished package. Detects all types of metal, magnetic or non-magnetic. Folder gives specs and descriptions of operation. E. W. Brilmayer Labs., Inc. (109-I)

EXTRUSION COATING EQUIPMENT. Illustrated 8-page brochure with diagrams, discusses in detail the operation and process of extrusion coating and laminating with improved machinery and accessories. The Black-Clawson Co. (110-I)

VINYL RESINS. Colorful 12-page booklet completely illustrated, describes research and development efforts towards new plastics and quality control in a modern technical center. Photographs and drawings show chemists, physicists and engineers that work on new applications for vinyl resins. Diamond Alkali Co., Plastics Div. (111-I)

AUTOMATIC WEIGHT SENSING. 8-page reference manual shows how measurement of weight or force is applied for automatic control. Illustrations and diagrams show the process of how automatic weighing sorts, classifies and divides by weight groups. The manual also shows typical applications. The Exact Weight Scale Co. (112-I)

HYDRAULIC PRESSES. 8-page brochure describes hydraulic presses for the rubber, plastics and fibre glass industries. Illustrated machines include those for compression molding, transfer molding, laminating and down-acting presses. Illustrations of presses and accessories with specifications of each press. Erie Engine & Mfg. Co. (113-I)

UNIVERSAL TAKE-OFF MACHINES. Insert describes machines for take-off of all profiles, cables, tubes and sections at variable speeds. Illustrations and drawings show operation and specifications. Farris Universal Machine Corp. (114-I)

PLASTIC WELDER. Illustrated pamphlet describes high frequency welding machine for plastics. Machine is designed to save space and is mobile, can be operated by one person with a foot-pedal. Complete design specifications included. Flodins Industri AB. (115-I)

MOLDING COMPOUNDS. Illustrated 8-page booklet shows research and manufacturing facilities where Glaskyd Alkyd Molding compounds are developed and produced. Booklet also discusses Glaskyd Alkyd Compounds in rope form, their molding cycles, other specifications and includes application charts, plus a description of technical services available. Glaskyd Inc. (116-I)

CADMIUM LITHOPONES. Folder shows cadmium lithopones available with a variety of 12 reds and 6 yellows shown. Brochure traces the technical development of cadmium lithopones and describes applications. General Color Co., Inc. Div. of H. Kohnstamm & Co., Inc. (117-I)

SPRUE AND SCRAP GRINDERS. 30-page catalog illustrates and gives specification of stock model sprue and scrap grinders. Models shown include portable grinders and an all-purpose granulater among others. Specifications and prices are included. Injection Molders Supply Co., Inc. (118-I)

DIAL COATING. Brochure describes Anchor dial filler, a specialized dial coating for embossed and recessed patterns. Has great opacity and is fast drying for plastics, metals and ceramics. Typical applications are illustrated, and brochure gives a free trial offer of Anchor dial filler. The Irvin, Jewell & Vinson Co., Div. of Hooven & Allison Co. (119-I)

EXTRUDING MACHINES. 4-page brochure illustrates a complete line of extruders, including accessories. Contains specifications and recommended drives. Killion Extruders. (120-I)

FILM STRETCHER. 11-page spiral bound manual discusses a film stretcher with flexibility and range to accurately investigate any stretching process. With illustrations and detailed description, it shows operation, features and attachments. Installation requirements and specifications included. T. M. Long Co. (121-I)

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EQUIPMENT • SUPPLIES • SERVICES

AIR & HYDRAULIC CYLINDERS. 30-page bulletin describes air and hydraulic cylinders, accessories and seal fittings for pipe threads, water fitted cylinders, air cylinders, boosters and accumulators. Includes specifications and discussion of power, strength, factors of safety and pressure losses. Miller Fluid Power, Div. Flick-Reedy Corp. (122-I)

RIGID POLYMERS. Illustrated 8-page booklet discusses Cycolac-brand polymers that have toughness, hardness and rigidity, in addition to other qualities. Illustrations show applications in a wide range of products. A comprehensive table shows typical properties of Cycolac. Marbon Chemical, Div. of Borg-Warner. (123-I)

TWIN-STATION BLOW MOLDING. 4-page brochure describes the MPM Diversamatic twin-station blow molding equipment. The Diversamatic utilizes the basic blow molding principles, and either identical or different molds can be run at the same time. Includes specifications and special features. Modern Plastics Machinery Corp. (124-I)

PRECISION TOOLS & EQUIPMENT. 4-page folder lists 150 pieces of major equipment with brief descriptions and dimensions. The equipment includes surface grinders, presses, lathes and other mold and die equipment. Newark Die Co. (125-I)

PLASTICS EXTRUDERS. 8-page illustrated brochure gives descriptions of space-saving plastics extruders. Brochure lists features and specifications of 3½", 4½" and 6" extruders for thermoplastic production. National Rubber Machinery Co. (126-I)

PLASTICS REINFORCEMENTS. Brochure describes roving, chop strand and reinforcing cloths with dimensions and special characteristics. Pittsburgh Plate Glass Co., Fiber Glass Div. (127-I)

BLOW MOLDING. Illustrated folder gives description and specifications of 8 different models of precision and blow-molding machines in single and double press models. Folder describes features and accessories. Plastics Machinery Div., The Producto Machine Co. (128-I)

INJECTION MOLDING DRY COLOR. Comprehensive manual gives vital technical data, prices for injection molding dry colors. Contains 72 color chips. Also for extruders and blow molders. Plastics Color Co., Inc. (129-I)

STEAM PRODUCTS. Bulletin punch-holed illustrates and gives description of steam jet cleaners, steam boilers and feed water systems that are both mobile and stationary. Pantex Corp. (130-I)

PLASTIC SHEET EXTRUDERS. Bound reference booklet contains 30 pages of description of various types of plastic sheet extruders and is an up-to-date guide for use in selection and ordering. Technical data and the most important aspects of materials are included. Raritan Plastics Corp. (131-I)

WORLD-WIDE PLASTIC SOURCES. 8-page booklet describes available epoxies, phenolics, polyesters, fiberglass and other plastic industry products that are available throughout America and the world. Complete data. Reichhold Chemicals, Inc. (132-I)

GRINDERS AND RECYCLING EQUIPMENT. Folder gives illustrations and descriptions of scrap grinders and plastic recycling equipment and systems. Foremost Machine Builders Inc. (133-I)

PHENOLIC RESIN. 4-page brochure gives physical properties, handling characteristics and other data about a new light-colored heat-reactive phenolic resin for industrial and general purpose elastomer adhesives. Schenectady Varnish Co., Inc. (134-I)

PACKAGING SET-UP. Bulletin describes six components including a heat sealer, cutter, former, and molder to improve packaging set-ups. Complete descriptions, data. Tronomatic Machine Mfg. Corp. (135-I)

HYDRAULIC PRESSES. Illustrated brochure describes hydraulic presses for rubber plastics and allied industries, including presses of all sizes for reinforced plastics, up-acting or down-acting, plus foundry equipment. Taccone Corp. (136-I)

TOOLING EPOXY RESINS. Extensive reference file gives general description of the products, facilities, and services of this company. The file discusses epoxy tooling compounds, fiberglass and accessory materials, epoxy paints and primers. Tylene Plastics Co., Div. if Armstrong Resins, Inc. (137-I)

EXTRUSION COATING AND LAMINATING. Brochure gives data on extruder coater-laminator and integrated web process system. Brochure discusses important new design features of the equipment. Waldron-Hartig, Midland-Ross Corp. (138-I)

RADIANT HEATERS AND PANELS. 8-page booklet punch-holed for binder gives extensive data and illustrations of radiant heaters and panels, lamp replacers, controls and accessories, and shows application and special features. Edwin L. Wiegand Co. (139-I)

DOUBLE ROTATION OVENS. 4-page illustrated brochure describes a double rotation oven for the molding of vinyl plastisols. Unit, which accommodates two steel frame mold holders simultaneously, features horizontal loading door and hinged access door. Brochure also describes auxiliary equipment. E. B. Blue Co. (140-I)

BLOW MOLDING EQUIPMENT. Illustrated 4-page brochure lists specifications and describes components and operations of blow-molding machines with production capacities to 450 pounds of material per hour. Auto-Blow Corp., A Subsidiary of National Cleveland Corp. (141-I)

RUBBER & PLASTICS MACHINERY. 32-page brochure describes a broad range of hydraulic presses. New features include mat presses, a breech block and open-side presses. Stewart Bolling & Co. (142-I)

ADDING LIQUIDS TO SOLIDS. 4-page illustrated folder describes equipment for accurately controlled, continuous application of liquids to solids. For application of binders, surface treatments, tempering with water, prewetting of suspensions, etc. Complete description, principles of operation, applications, specifications. Johnson March Corp. (143-I)

OVENS. 3 data sheets cover developments in ovens applicable to plastics industry. "Teflon" cabinet type with direct gas, cross flow; "Teflon" cabinet type with direct gas; electric cabinet oven for silastics discussed. Lydon Brothers, Inc. (144-I)

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Progress in spray-up

(From pp. 88-92)

but lays them continuously with catalyzed and promoted resins.

Finn and Fram Inc., Sun Valley, Calif., makes a universal chopper for any gun. It also offers a polyester spray system with a single nozzle, requiring no pre-mixing of resin and catalyst. Percentage of catalyst is changed by turning a knob. The gun is made by Binks Manufacturing Co., Chicago, Ill.

Peterson Spray Gun Co. Inc., Belmont, Calif., produces a twin-tip gun with a glass breaker called the Glass Hog and makes complete installations. Peterson Products, also Belmont, is an operating molder by spray-up and contributes to the continuous improvement and modification of Peterson guns.

Plastic Engineering and Chemical Co., Fort Lauderdale, Fla., specializes in a gun that is said to be particularly effective in overhead applications. They also specialize in an inexpensive device manufactured by De Vilbiss Co. for cleaning of any hose system.

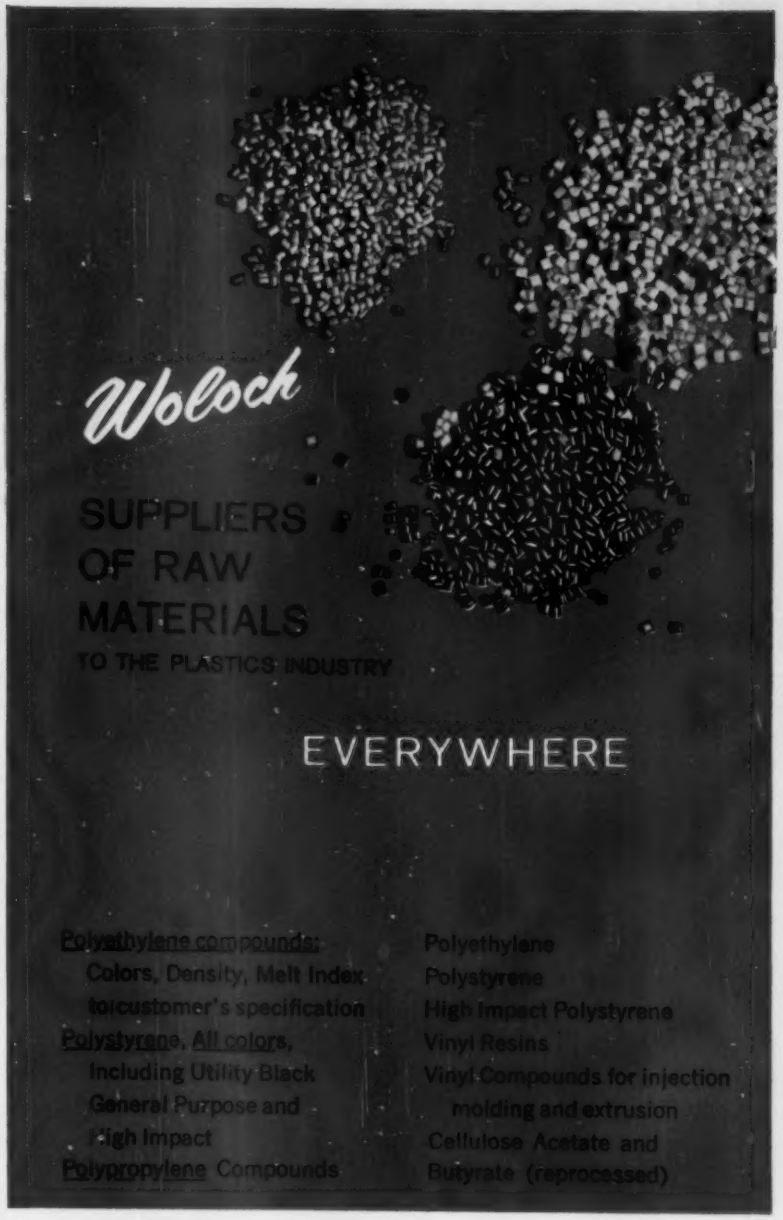
Rand Development Corp., Cleveland, Ohio, some time ago rejected the system which used DMA and benzoyl peroxide for a system using cobalt naphthenate promoter and MEK peroxide. Rand also offers a new small depositor for small and difficult-to-reach areas. These may be completely automated for molding of small parts.

Sealzit Co. of America, subsidiary of the Flintkote Co., Riverside, Calif., makes a new gun which shoots material in any selected direction, not being dependent on gravity for deposition. The Sealzit gun has catalyst control by dial and is stated to be easily cleaned by the use of a flush valve and small amounts of solvent.

Spray-Bilt Inc., Hialeah, Fla., has a series of spray-up guns ranging from portables to complete plants. A new gun adapter from this company sprays fibrous glass plus asphalt. The company's gun can also shoot continuous-strand roving upon removal of the blades of the glass breaker.

In England, Synthetic Applications Ltd., Hayes, Middlesex, offers a system which uses either pressure pots or fluid pumps for delivery.

No article on spray-up would be



Plastics Scrap
Surplus Molding Powder
Off-specification Resins
and Compounds

INTERPLASTICS

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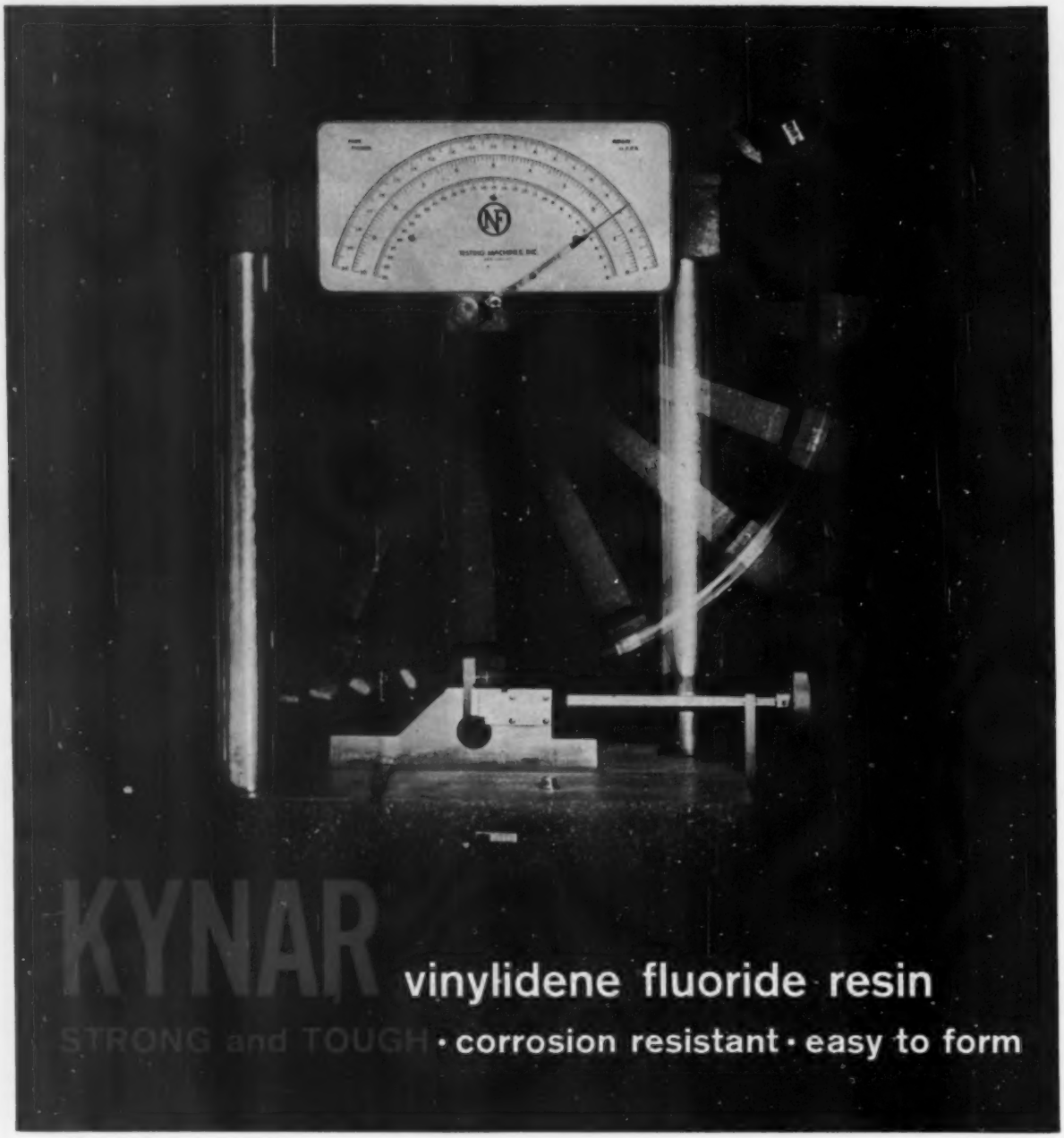


This high molecular weight polymer offers excellent resistance to all types of stress and wear. Check these values:

- **Izod impact,** unnotched, at 77°F: 30 ft-lb/in
- **Tensile strength** at 77°F: 7000 psi; at 212°F: 5000 psi
- **Modulus of elasticity** in flexure at 77°F: 2.0 x 10^5 psi
- **Abrasion resistance,** Tabor CS-17, ½ kg load: 17.6 mg/1000 cycles
- **Durometer hardness,** Shore D, scale: 80
- **Creep:** 0.07 in/in at 3000 psi and 77°F.

Evaluate Kynar for applications in which you can profit from its unexcelled combination of properties—***resistance*** to chemical corrosion, heat and weathering . . . ***formability*** by all usual methods, on standard equipment . . . and high ***strength.*** Write for further information, samples or technical aid. Research Products Development Dept., PENNSALT CHEMICALS CORPORATION, P. O. Box 4388, Philadelphia 18, Pa.

Pennsalt Chemicals
ESTABLISHED 1850

**Kynar is a trademark of Pennsalt Chemicals Corp.*

complete without discussing the litigation over patents now going on.

As clearly as this reporter can determine the facts, a man named David F. Anderson in Canada and another named Hugo Hanusch in Germany developed fiber-resin spraying processes at about the same time. The Anderson patents were assigned to the Canadian Ingersoll Rand Co. Ltd. and licensed exclusively to Rand Development Corp. A subsidiary of Canadian Ingersoll is Ibis Enterprises Ltd., Bermuda, B.W.I. The Hanusch patents were assigned to Cimex Trust Reg. who in turn licensed Aust & Schüttler u. Co. It is reported that Cimex Reg. is bringing infringement action against two European companies.

Meanwhile, Rand and Canadian Ingersoll have suits pending against Peterson Products and against Stanray Corp.; Ibex Enterprises Ltd. and Rand Development have a suit against Spray-Bilt Inc., which has a countersuit against Rand.

A licensee of Rand Development Corp. is Sealzit Co. of America. In order to use the Sealzit system, a company must now take out a license under the Rand patents.

There are two interesting developments in spray-up marketing, largely occasioned by the fact that so many new and small companies are getting into the business of making things with spray guns.

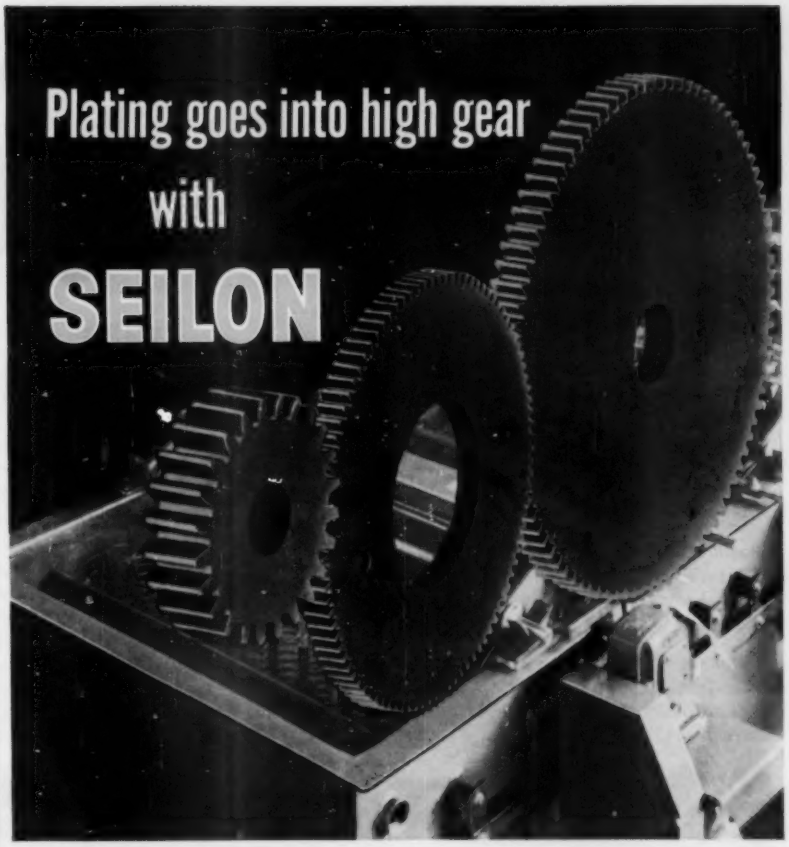
First, there is the growing business of renting or leasing equipment. Second, there is the development of franchised distributors of fibrous glass, resins, catalysts, etc. While a manufacturer of fibrous glass or resin can handle carload orders direct, single drums of resin and a few cones of roving to be delivered here, there, and the other place cannot be handled quickly and efficiently by large companies. At least 40 such distributors are in existence in the U.S. today.

References

1. J. W. Mitchell, Ph.D., W. A. Mitchell and Smith Ltd., Reinforced Plastics, Sept. 1960.

2. C. E. Hayes, Riggs & Lombard, SPE Journal, June 1961.

3. J. J. Bogner, R. Burkel, and R. D. Goold, Chemical Process Co., paper before the RP Div., Society of the Plastics Industry Inc., Feb. 1961.—**End**



METAL GEAR DRIVES for plating barrels had never been wholly successful. In certain solutions the metal would deteriorate and cause contamination. Maintenance and replacement costs were high. Plastics had been tried, but no plastic was found that wouldn't swell, distort, crack, coat-up, or simply dissolve in some plating solution, acid or alkali, at temperatures up to 220°F. None, that is, until The Singleton Company of Cleveland discovered . . .

SEILON S-3HT: A TOUGH THERMOPLASTIC ABS POLYMER. In collaboration with Seiberling technicians, Singleton produced the first gear train with universal application in the plating industry. The exceptional strength, machinability and chemical resistance of SEILON S-3HT make Singleton's gears practically indestructible and inert to all solutions. Singleton's SEILON gears have many potential applications. Along with gears of SEILON PRO and PVC they are being investigated by several industries, and are actually in trial operation in the machine tool industry.

SEILON is versatile in its many properties and tailor-made adaptability to your requirements. We welcome the opportunity to help solve your problems—a letter or phone call will start us working.

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New from Emery Research

4 New Polymerics

Emery research has achieved a significant breakthrough in the field of polymeric plasticizers. Four new polymerics have been introduced to complement Plastolein 9720, the industry's largest selling polymeric. Together, they now give you a single source for a wide range of your plasticizer needs. Although Plastolein 9720 will continue to be the choice in uses demanding its ease of processing and low viscosity, the four new plasticizers meet other needs:

Plastolein 9722: An improved version of Plastolein 9720 in humidity and outdoor aging, compatability, extraction and migration—at the same low cost. (Formerly Emery 3282-D)

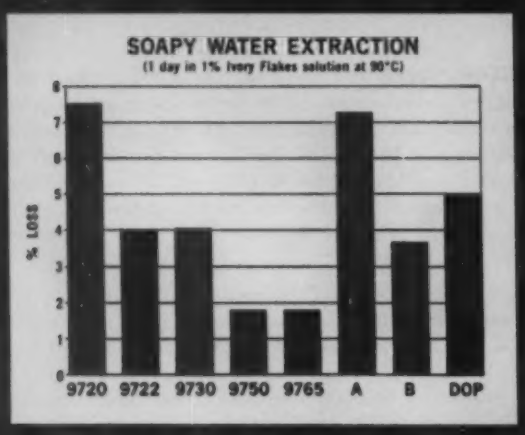
Plastolein 9730: Now, the lowest cost polymeric plasticizer featuring low migration properties, excellent outdoor stability, and good soapy water resistance. (Formerly Emery 3311-D)

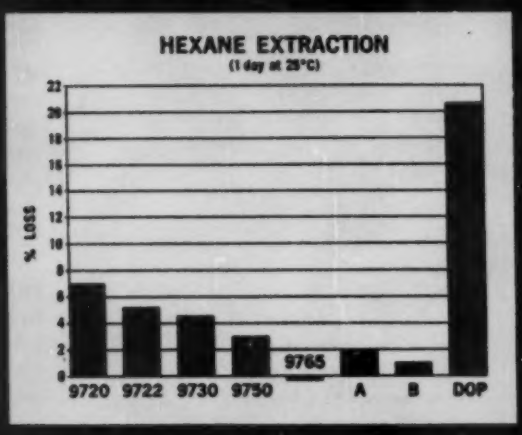
Plastolein 9750: A good, general-purpose, medium molecular weight polymeric at low cost, with excellent soapy water extraction and outdoor stability. (Formerly Emery 3313-D)

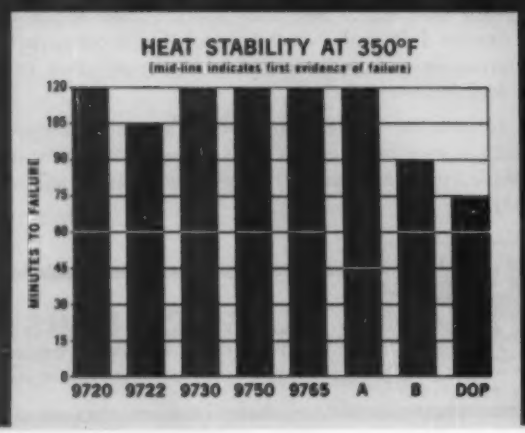
Plastolein 9765: The medium molecular weight polymeric plasticizer offering the best all-around permanence. Its cost is low, humidity aging outstanding, and extraction resistance tops. Special deodorized grade available. (Formerly Emery 3314-D)

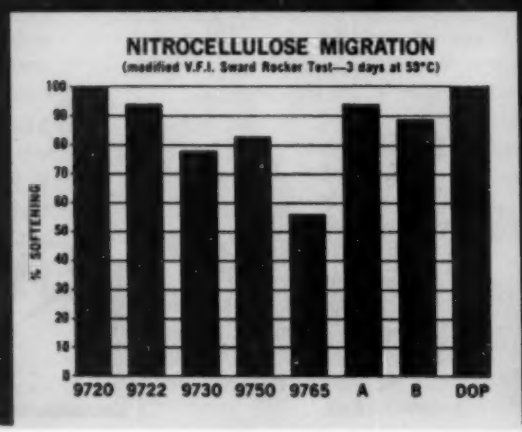
Extensive aging tests have been conducted by the South Florida Test Service. The Emery polymerics were compared with two leading competitive plasticizers and with DOP. Results show outstanding superiority of the Plastolein polymerics. Full information on the new Plastolein Polymeric Plasticizers including reproductions of test samples is available in Technical Bulletin 424. Write Dept. F-9.

Check Plastolein Polymeric performance on eight









now the most complete line of low cost polymeric plasticizers in the industry

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	PLASTOLEIN 9720	PLASTOLEIN 9722	PLASTOLEIN 9730	PLASTOLEIN 9750	PLASTOLEIN 9765
Coated upholstery fabrics	●	●	●	●	●
Unsupported films	●	●	●	●	●
Baby wear	●	●	●	●	●
Wall coverings	●	●	●	●	●
Vinyl-metal laminates	●	●	●	●	●
Industrial tapes		●	●	●	●
Shoe constructions	●	●	●	●	●
Surgical tapes				●	●
Plastisols, organosols	●	●	●	●	●
Coated paper	●	●	●	●	●
Pigment grinding	●	●		●	●
Refrigerator gaskets					●
Flooring	●	●	●	●	●
Hospital sheeting					●
Crash pads				●	●
Vinyl foam	●	●	●		

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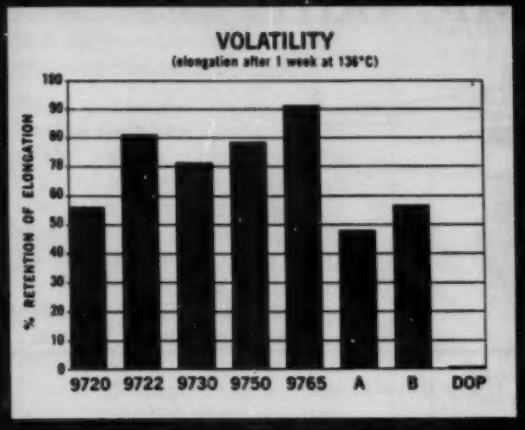
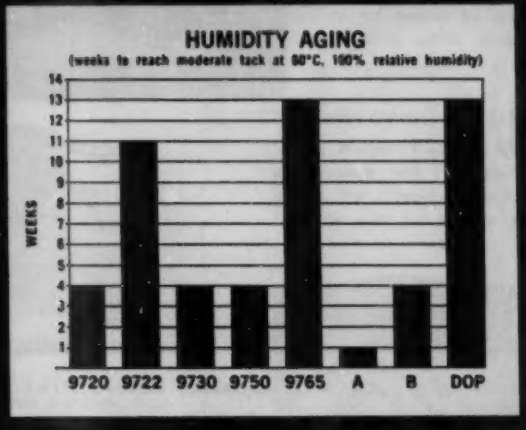
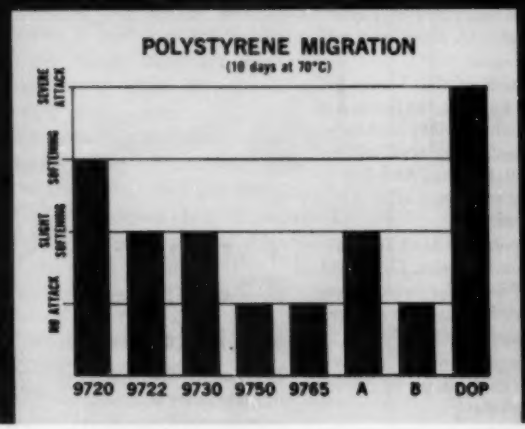
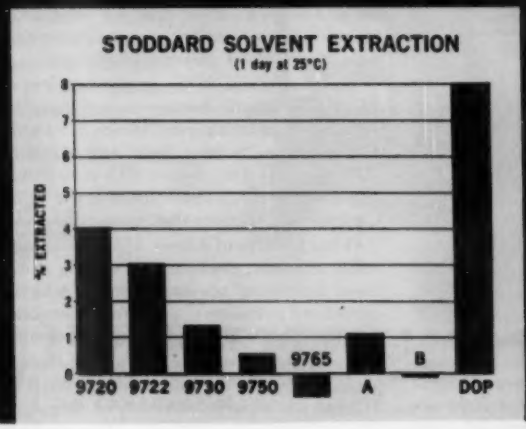
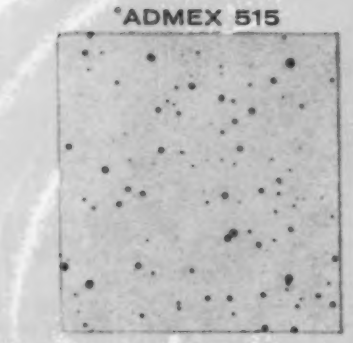
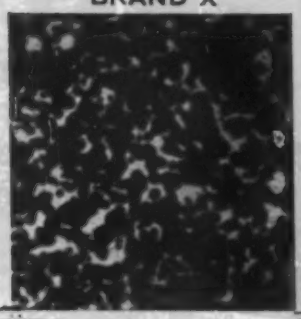




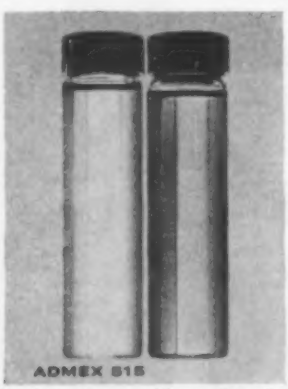








Arizona exposure test proves Admex 515 permanence best under the sun!



LIGHTER COLOR. *Admex 515 color averages 3 to 5 Gardner ('53) tubes lighter than competitive plasticizers. This gives you clean, light color in compounds, ideal for white and pastel products.*

Clearly superior color...freedom from exudation

There's a lot of talk about plasticizer permanence . . . but here you really see it! The photos above show two clear vinyl films (both 50 PHR) after 6 months' Arizona exposure: one containing Admex 515, the other a well-known competitive polyester plasticizer.*

Compare them. Note the nearly clear condition of the Admex 515 film . . . the drastic deterioration of the other. At a glance, the functional superiority resulting from Admex 515's unique light stability is obvious. For resistance to heat, light and humidity; gasoline, mineral oil and solvent extraction, Admex 515 is definitely outstanding. And just as important in many applications is the light color of Admex 515—3 to 5 Gardner tubes lighter than competitive plasticizers.

Other features of Admex 515 include low temperature flexibility, low, stable viscosity, good pigment wetting and economical price. Combined, these functional advantages make Admex 515 ideal for: coated and calendered upholstery, pigment dispersions, electrical insulation, paper coatings, profile extrusions, dipping compounds, vinyl foam.

If a superior plasticizer for any of these applications would help you profit, write, wire or call us today. We'll send you a sample of Admex 515 and complete information on this unique product.

**Test panels were 45° South, direct to the weather.*

Archer-Daniels-Midland

CHEMICAL GROUP
717 INVESTORS BUILDING
MINNEAPOLIS 2, MINNESOTA

A tough case

(From page 93)

(in five figures) required annually by the company. Specifically, a vacuum-formed case for the new meter was costed out at $5.45/unit, with tooling costs of approximately $2,500, while the injection-molded case is priced at $3.50/unit, even though tooling costs with this method are about $9,500 higher. It is believed by the manufacturer that the outer shell represents the first successful use of an injection-molded carrying case for an office machine in this country.

The shell halves of the case are molded in two cavities on a 32-oz. machine. Each mold cavity is hand-tooled in a pebbled pattern, which imparts a "Scotch grain" texture to the outer surface of the shells. Cored hinge parts are integrally molded into the shell bottoms and carrying handles into the tops. Two hinge ramps, both undercut at one end, are molded into one of the shell halves. The two halves are joined by inserting the open ends of two wire bails (see illustration, p. 93) into the cored hinge parts, and pushing the closed ends of the bails up the molded-in ramps until they snap into the undercuts.

Other protective design features

The integral handles, when gripped, prevent the meter from falling out of an unlatched case, since they exert closing pressure on the latch hardware located on the top center line of the case. As another protective measure, the bottom walls of the two shells are angled upward toward the latch. Besides allowing a clearance between the molded hinges and a flat surface, this design puts pressure upward and inward to keep the shell halves together, even when unlatched, when the case is stood on its end.

Credits: Injection molding and foam molding by Worcester Moulded Plastics Co., vacuum forming by Crystal Plastics Inc. Kralastic L (ABS) molding material supplied by Naugatuck Chemical Div., U. S. Rubber Co., Boltaron (ABS) sheet by Bolta Products Div., General Tire & Rubber Co., and Dylite expandable PS beads by Koppers Co. Inc. Carrying case styling by Lippincott & Margulies.—**End**

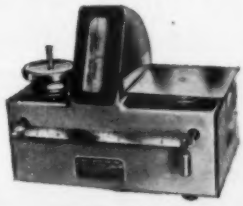
EXACT WEIGHT® offers savings for your injection molding

NEW COMPACT SMALL CAPACITY WEIGH-FEEDER

TYPE 6130

This new compact weigh-feeder is designed for injection molding machines of 10-ounce capacity and under. Completely enclosed, it is easily mounted over feed chamber of the molding machine. Its operation is fully electric and requires no compressed air. This unit has all the automatic features of the widely accepted Exact Weight Model 610 Series Weigh-Feeder. Write for Bulletin 3485.

Improved quality of molded parts . . . savings of materials . . . speed-up of molding cycle . . . fewer rejects. Exact Weight Plastic Weigh-Feeders offer these and other important advantages. The precision industrial scale with over-and-under indication and precision controls provide extreme accuracy. Plunger Position Control is fully automatic, effective with either starve or cushion feeding. These machines are backed by more than 45 years of experience in designing and manufacturing industrial scales. Service facilities in all principal cities.



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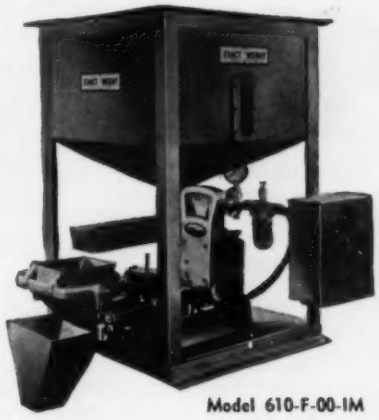
Exact Weight Plastics Weigh-Feeders are available with capacities up to 200 ounces. For complete details and specifications, write for Bulletin 3321.



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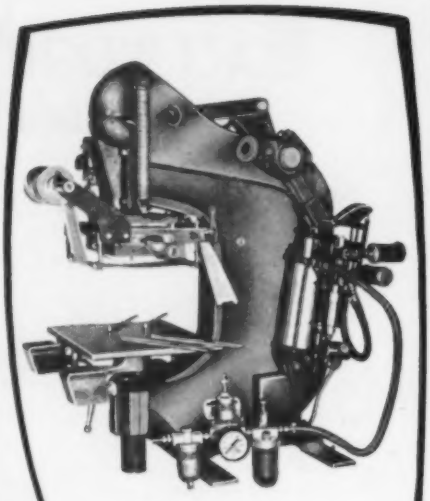
A model can be supplied to meet any production requirements: Hand-operated, Air-operated, Semi-automatic, and Completely automatic.

Compressed air-operation, adjustable electric dwell-timer, thermostatic heat control, and rugged construction are a few of the features which assure quality marking.



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Heavy-Duty
Air-Operated Power Press

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Specialists in Quality Marking Equipment and Supplies for over 30 years

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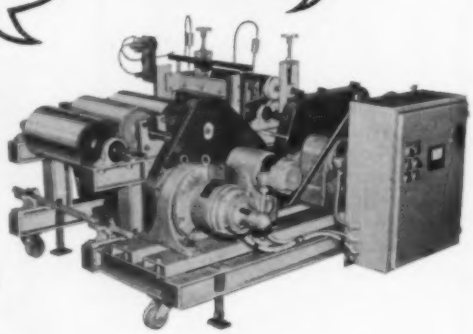
Fine uniform quality, economically priced roll leaf in genuine gold, high luster imitation gold and silver, and both flat and Enamel pigment colors.

Why are LIBERTY EXTRUDER EMBOSSER-LAMINATOR HEADS my best buy?

Because they are CUSTOM-MADE to fit exact requirements!

Yes, that's right—custom-made **—at mass production prices—** to fit **your** need. Made in all widths to fit all standard vinyl extruders in both production and laboratory models. Features:



- **Complete controlability of all phases of operation.**
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  Embosser-laminating heads.
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This machine is another in the great Liberty line of web processing equipment. For more information about this or any other item of web processing equipment, write, wire or phone to Liberty—the house that builds machines with **quality where it's needed and economy where it counts.**

LIBERTY MACHINE CO. INC.
275 Fourth Avenue, Paterson, New Jersey

Polypropylene chairs

(From pp. 94-95)

regardless of cost, could take this treatment. At the same time, because of the resilience of the material, the contour of the chair accommodates itself to that of the seated person, giving him the feeling that the chair was custom-fitted just for him. And with all its strength characteristics, the entire chair weighs only 5½ pounds.

And, of course, the chair exhibits all the other well-known properties of polypropylene: It will not fade in normal use, remains rigid at temperatures up to 275° F., is easily cleaned, is stain resistant, and is unaffected by alcohol, lighter fluids, nail polish, oils, greases, etc.

The high quality of the chairs is assured through a rigorous testing program conducted by the molder. For example, in a torture test, a 165-lb. weight suspended by four chains from an hydraulic cylinder is dropped on the seat of the chair. At the same time, an air-cylinder-operated piston hits the back of the chair, while an over-all rocking motion induces high shearing forces. After running this test 135,000 times, the molder reports that there was no wear on the PP chair. This is more abuse than could be given in a lifetime of normal usage. As a cold test, the manufacturer states that two packed boxes of four chairs each were dropped 8 ft. in a chamber held at −10° F. There was reportedly no breakage.

Machinery for molded thermoplastic chairs of this type was originally developed by Plaxico, a French plastics firm. The company used it to mold high-impact polystyrene and later high-density polyethylene chairs. In 1959, the American manufacturer signed an agreement with the French firm for exclusive rights to the mechanical patents for North and South America, the Philippines, and Japan. Plaxico holds patents for the rest of the world. The American manufacturer redesigned the chair and now holds the design patent. Plaxico uses the American design on a reciprocal royalty basis.

Credits: Chairs manufactured by Alladin Plastics Inc., Gardena, Calif., using a machine built by National Automatic Tool Co. Resin currently used is AviSun's 3116 PP. Nylon plugs molded by Alladin.—**End**

Versatility *in* *Urethane Foam Production*

Gabriel Williams

FOAM MACHINES FOR EVERY URETHANE APPLICATION INCLUDING FOAM-IN-PLACE AND SPRAY UNITS

FULLY AUTOMATIC

Capacity ranges from 150 grams to 175 lb per minute.

These versatile units are designed to make a full range of polyether, polyester, dimer base or halogenated hydrocarbon self-blowing foams—flexible, rigid or semi-rigid—in the densities desired. Available in 2, 3 or 4 components.

The automatic mixing head is standard equipment for use in making predetermined intermittent mold fills or for continuous operation. Automatic flush and air jet for cleansing mixing head included.

Consult Gabriel Williams for every industrial application.

GW

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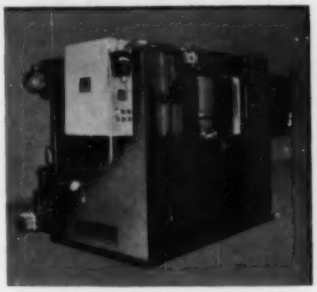
77 Mill Road, Freeport, L. I., N. Y.
Cable: GAWILL FREEPORTNY

For makers of HOLLOW GOODS or MULTI-PART ASSEMBLIES!

(in aircraft, autos, construction, electrical industrial, household, toys, etc.)

"ECONOMY" equipment for hollow parts molders makes large or small production easy on short notice. Minimum cost tooling is quickly obtainable. The flexibility of "Economy" professional heavy duty machinery helps meet changing market needs. Jobs that are *uneconomical* for ordinary metal working or molding may be profitable in cast thermoplastics.



"ECONOMY" custom builds:

- **rotational molding ovens**
- **"No Drip" filling outfits**
- **automatic cooling units**
- **speed stripping stations**
- **ovens, conveyors, dust**

collecting systems, spray booths, tanks, ductwork, etc. to specification.

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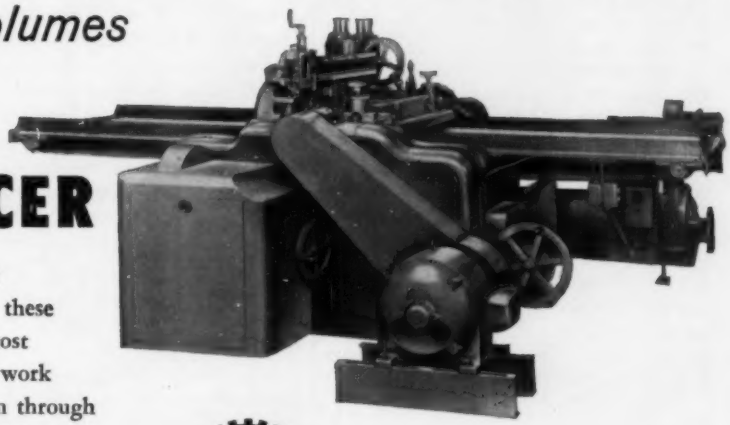
Rubber, vinyl, phenolic, acetate, plastics, laminated sheets and similar materials are profitably machined in large volumes on the BUSS MICRO-SURFACER



Grinding and sanding plastics and thin-sheet materials is obsolete. Now you can machine these products faster, more accurately at far less cost with the Buss Micro-Surfacer. The vacuum work table flattens flexible materials, feeding them through carbide cutterheads which rotate at high speeds. Assures smooth, precision surfacing, at high feed rates and to close tolerances. Materials to 72" wide are machined at required feed rates. Shavings vanish through an efficient exhaust system. Investigate the Buss Micro-Surfacer . . . eliminate obsolete surfacing operations now.

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Precision parts

(From pp. 96-99)

components generally involve tapers, undercuts, molded-in threads, inserts, etc., extrusion is rarely used (an exception is low-cost ball point pens which are essentially simple tubes filled with ink).

Injection molding: Pen and pencil parts are a challenge to injection molding because of their small, detailed geometry and the close tolerances required. These parts seldom weigh more than $\frac{1}{10}$ of an ounce. A typical part would be one having a hollow, cylindrical cross-section, with both inside and outside molded-in threads. Sidewall thickness will range from 0.015 to 0.050 inch. Bore diameter will vary from 0.050 to 0.400 inch. Outside diameters are in the order of 0.025 to 0.500 inch. To satisfy the company's high quality standards, parts must be molded free of all visual defects such as sinks, streaking, or flow lines. Normal tolerances on most dimensions are ± 0.001 to ± 0.002 in., with some of the critical sections dropping as low as ± 0.0005 inch.

The company uses 3- to 5-plate molds containing from 8 to 32 cavities. Good uniformity from part to part has been achieved using geometrically balanced cavity layouts having equidistant runners. Full-round or trapezoid cross-section runners having an approximate diameter of 0.200 in. are preferred.

The company's insistence on balanced runners is based on the conviction that this type of layout helps insure parts of uniform strength and dimension from one shot to another. Tests have indicated that on unbalanced sprue systems, where the material flow distance varied from one part to another, a considerable difference may be found in the physical properties of parts from different cavities.

It is also interesting to note that practically no use is made of so-called family molds. It is the feeling of the company's plastics technicians that this type of mold is, by necessity, a compromise with quality, since parts of different geometry have different optimum molding conditions, and that the use of such a mold is likely to lead to some reduction in parts quality.

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molding techniques have been developed for two important pen components in the line—the Jotter pen barrel and the "61" pen collector shell (see photos, pp. 97 and 98).

The Jotter pen barrel is single-point gated at the base of the threaded connector. This part is being produced from cellulose propionate, molded in a 16-cavity die using 0.030-in.-diameter full-round pin-point gates. The small metal tips at the front end of the barrel are insert molded, with the inserts pneumatically loaded into an insert loading fixture by means of a special device located beside the press. This arrangement greatly expedites the handling of the tiny inserts, which with a 16-cavity mold would take a considerable amount of the operator's time if the entire operation were handled manually.

Pin-point gates are not the only type used. For example, for the "61" collector shell, which must be held to very close dimensional and strength requirements, it was established that pin-point gating was not advisable. This part is now being successfully molded in a 12-cavity mold using ring gates which encompass the entire base circumference of the part. The ring gate provides a more constant filling of the cavities and a stronger weld line. The collector shell is molded slightly longer than needed, and a secondary machining operation is used to trim off the ring gate and the inherently weaker plastic material adjacent to the gate area. This part, run in high-impact acrylic, can withstand a hoop stress loading of more than 1000 p.s.i.

One reason for the difference in techniques used on the two parts described above is that with the Jotter barrel hoop stress is not a problem, due to its less complex design and exclusion from ink as compared to the "61" pen collector shell. In addition, the dimensional requirements on the collector shell are much more critical.

Machining: Machining was one of the first methods used to mass produce pen and pencil parts. A good example of what can be done in the mass production machining of plastics is the "51" fountain pen. All of the major plastic components used in this pen are machined entirely from cast acrylic sheet. More than 31 successive machining op-

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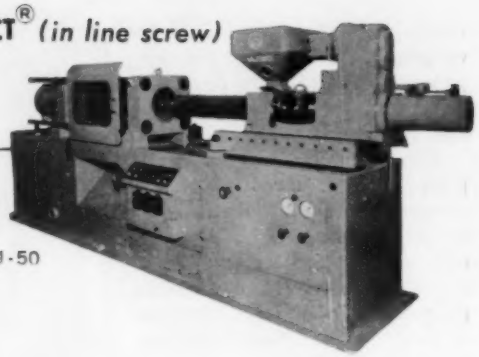
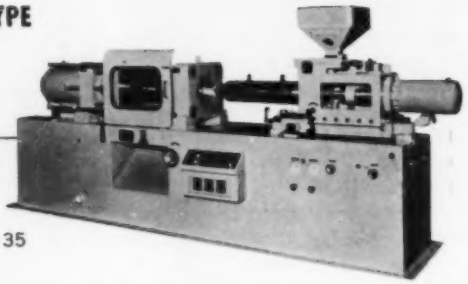


SJ-50

■ **PLUNGER TYPE**



H-35

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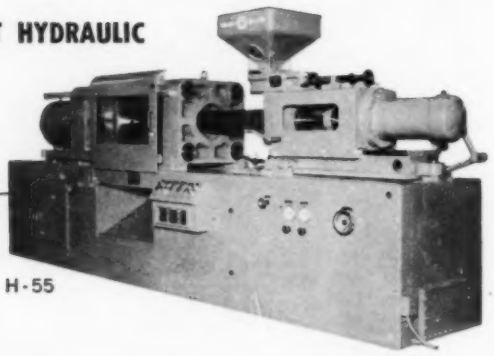

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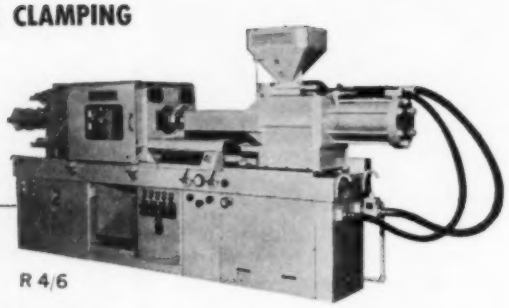

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SPECIFICATIONS

AD-52

MODEL		SJ-SERIES							H-SERIES						
TYPE		SCREW & STRAIGHT HYDRAULIC							PLUNGER & STRAIGHT HYDRAULIC						
NO.		SJ-35	SJ-50	SJ-60	SJ-75	SJ-90	SJ-120	SJ-150	H-8	H-16	H-35	H-55	H-85	H-120	H-180
OZ. PER SHOT		6	16	32	72	120	360	1100	1.5/2	3/4	8/10	12/16	20/28	40/52	60/80
CLAMPING FORCE (U.S. TON)		84	195	310	480	850	1250	2500	40	84	195	310	480	850	1250
SPACE BETWEEN TIE BARS	H	10 1/4"	14 3/16"	18"	26 3/16"	39 3/8"	48 1/2"	54"	8 1/16"	10 1/4"	14 3/16"	18"	26 3/16"	39 3/8"	48 1/2"
	V	6 5/16"	11"	16"	22 1/4"	35 7/16"	40 1/2"	54"	5 5/16"	6 5/16"	11"	16"	22 1/4"	35 7/16"	40 1/2"

erations are performed on the eight different plastic parts.

Cast acrylic sheet was chosen because of its luster, its void-free, stress-free structure, excellent machinability, and outstanding dimensional stability in writing inks. These sheets are purchased in a ½-in. thickness, are sawed into strips and ground into rods, and then sectioned, turned, bored, threaded, etc. Final tolerances can be held to ±0.001 to ±0.002 in., or less where needed.

The collector (see photo, p. 99) is a good example of close tolerance machining. The function of this component, used on both the "51" and "61" models, is to act as an overflow chamber which compensates for changes in atmospheric pressure and thus prevents leakage.

The collector is fabricated using a total of some 13 secondary operations on automatic equipment. In these machining operations, the following general sequence of operations is involved. After the rod is blanked to proper length, it is counter-bored, the diameter is stepped down, and the part is turned and faced to length. Next comes a second counter-boring operation, followed by rough profiling. The part is then grooved and slit longitudinally, after which it is circumferentially grooved, deburred, ultrasonically cleaned, washed, and dried. Tolerances on this unique part, which would be almost impossible to produce by injection molding, are: bore, ±0.0005 in., length, ±0.003 inch. The 24 fins, 0.010-in. thick, are spaced 0.010 in. apart.

Plastisol molding: Polyvinyl chloride plastisols are used to produce various flexible fountain pen components, such as ink reservoir sacs, gaskets, seals, and other integral filling devices.

Years ago, prior to PVC, rubber was used for these parts, but these rubbers were chemically attacked by writing inks and became brittle. Special PVC formulations were devised, tested, and found to have outstanding resistance to inks and long aging qualities. Another big advantage was that, for the first time, clear, transparent ink reservoir sacs could be produced, offering a visual measure of ink supply. These vinyl parts are generally formed by plastisol dipping on steel

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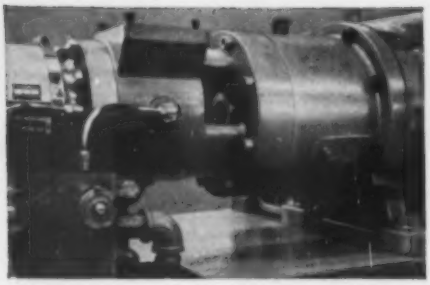

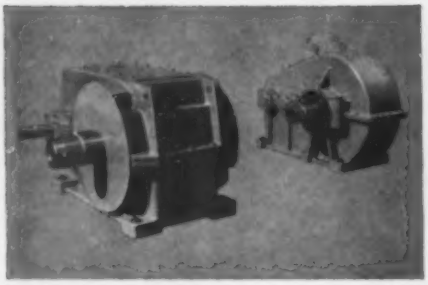

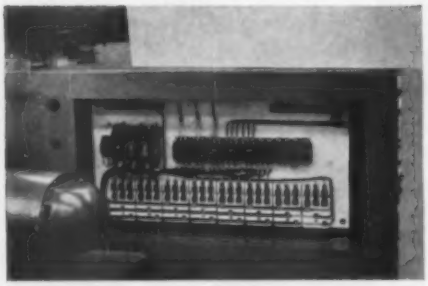

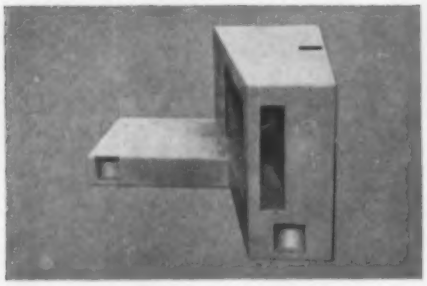

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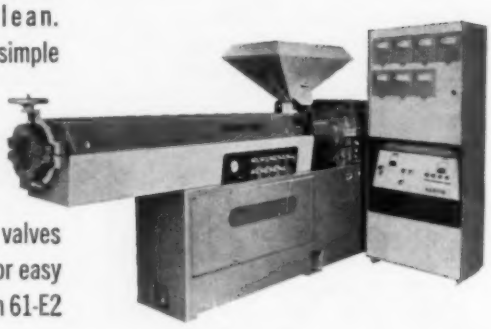

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arbors and, therefore, it is not possible to produce sharp-angle corners. But because of their flexibility, dimensions can be tailored to match-up with close-tolerance pen assemblies.

An ingenious combination of plastic and metal components makes possible the capillary self-filling feature of the "61" pen. As shown in the photo on p. 97, this mechanism involves the use of a small sheet or "foil" of cast PVC material, 0.001-in. thick, which is coiled within a metal tube or case having a fluorocarbon exterior coating. In the casting process (details of which are confidential), the thin sheet of PVC is given a series of built-in oriented ridges which serve as spacers when the material is later coiled and inserted in the metal tube. In addition, the PVC foil receives a number of minute perforations which contribute to the required wicking, or capillary, action when the end of the tube is immersed for a few seconds in a bottle of ink.

Because of this construction, when the film is tightly coiled each concentric winding has an interconnected passageway to adjacent layers. When one end of the vinyl coil is immersed in ink, a tremendous capillary force literally sucks the ink up into the maze of passages. In the "61" pen, the capillary force of this vinyl coil draws up enough ink in 10 sec. for more than 6 hr. of writing.

Plastics take hold

How successful this plastics program has been can best be illustrated by the fact that today as many as 75% of the component parts currently used in Parker pens and pencils are being made from plastics—and it is far from unusual to find as many as nine different plastics used in a single product. To other end-user industries, it is an outstanding example that precision workmanship and high production rates need not be diametrically opposed—but rather are particularly well adapted—to plastics processing. The best way to gain high quality and mass production is to begin with a well-engineered product, exercise judicious material selection, practice sound processing methods, backed up with a firm set of quality control standards.—**End**

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Humidifier

(From page 103)

reservoir, holding sufficient water for approximately 10 hr. of continuous operation. Its design includes recessed carrying grips and cored air duct openings, which are concealed by the base cover. Filling is accomplished by removing a tapered polyethylene cap, which is produced by the same molder in a six-cavity mold.

An impeller, injection molded of high-impact styrene, forces the water and air mixture through a stainless-steel screen, forming a fine mist that passes through the opening at the top of the separately molded dome. Resembling a miniature washing machine agitator, the impeller has six radiating vanes and a diameter of approximately 6 inches. The hemispherical shape of the dome efficiently directs the flow of vapor to the vaned outlet. Used in conjunction with the pump assembly is a slinger bushing molded of reinforced nylon.

In order to eliminate the annoying sound of water dripping back into the bottom reservoir, four "drip sticks," which are die-cut from extruded polyethylene sheet stock, are mounted through openings cored in the base cover. These "sticks" drain excess water quietly back into the base of the appliance.

Molding of parts

The three base components of medium-impact styrene are produced on a 24-oz. injection machine, using single-cavity molds for the reservoir and cover pieces and a two-cavity mold for the upper dome. A four-cavity mold produces two impellers and two caps that are used in conjunction with this part.

The polypropylene Humid-I-Mask attachment is connected to the vaporizer by a 4-ft. length of lightweight hose, molded of translucent beige vinyl over a coiled steel springwire core. Also included in the face mask assembly are two injection-molded polypropylene hose adapters.

The hose has the flexibility necessary to direct the flow of moisture to any required position of the user. When the mask is not being used, the lower end of the hose is readily detached from the outlet at the top of the domed housing.

Identification of the vaporizer is by means of a reverse-printed polyester film label with pressure-sensitive adhesive backing, which is applied directly to the molded styrene base.

Credits: *Molding and fabricating*—Hauser Products Inc., Chicago, Ill. (base pan, cover, dome, fill cap, impeller and cap); A. H. Kelch Corp., Thiensville, Wis. (mask and hose adapters); Dayton Rubber Co., Dayton, Ohio (hose); Kusan Inc., Nashville, Tenn. (slinger bushing); Penn Fibre & Specialty Co., Philadelphia, Pa. (drip sticks); Applied Plastics Corp., Milwaukee, Wis. (head band); and W. H. Brady Co., Milwaukee (nameplate). *Materials suppliers*—Union Carbide Plastics Co. and Dow Chemical Corp. (styrene); U. S. Industrial Chemicals (low-density polyethylene); Phillips Chemical Co. (high-density polyethylene); AviSun Corp. and Hercules Powder Co. Inc. (polypropylene); Polymer Corp. (filled nylon); and Du Pont (polyester film).—**End**

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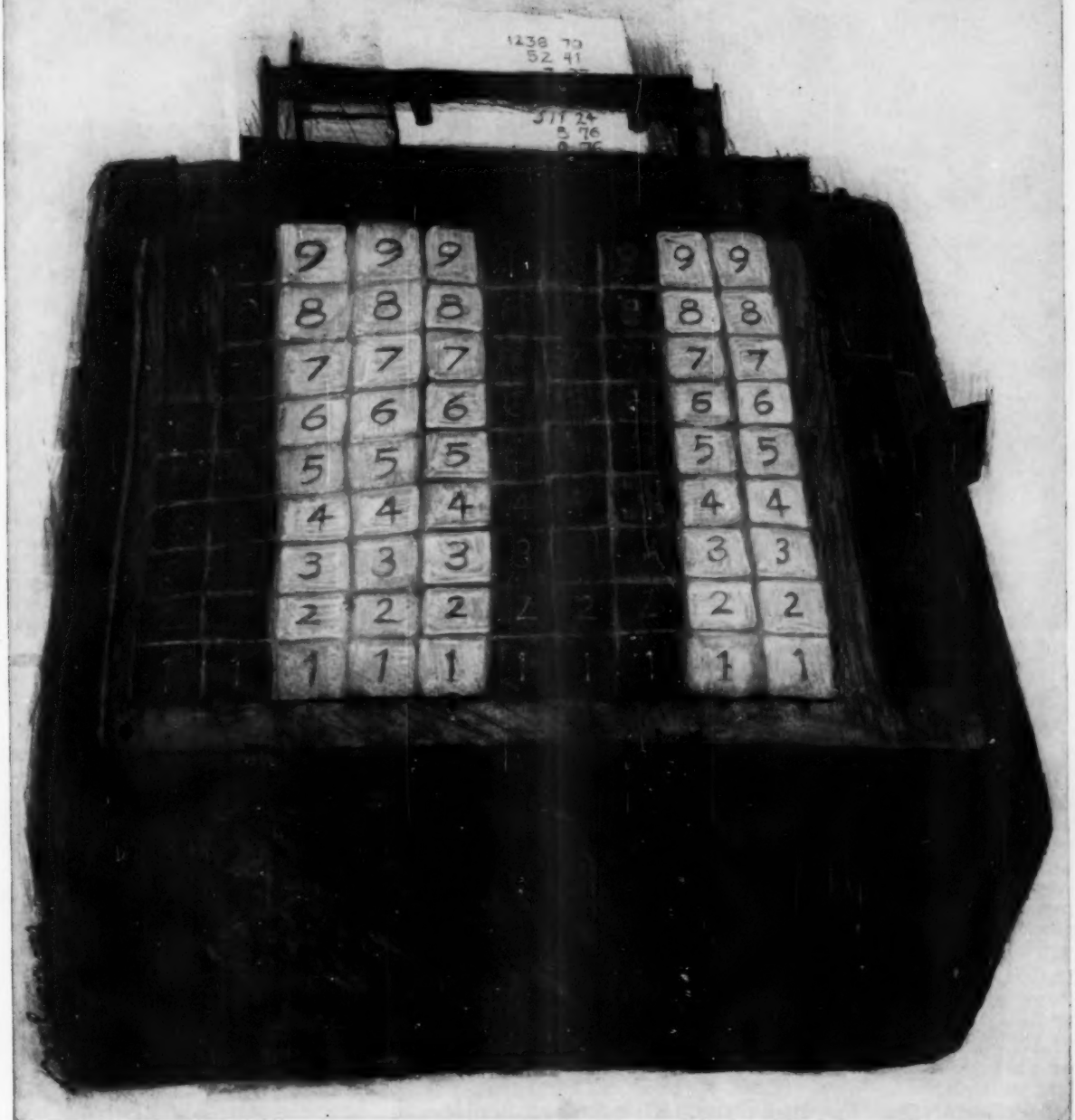

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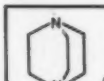

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Patent Reference: The use of triethylenediamine as catalyst in production of polyurethanes is covered by U.S. Patent No. 2939851 issued to Houdry Process Corporation. Corresponding patents have been issued in a number of foreign countries. Other U.S. and foreign patent applications pending.

Molding vs. casting

(From pp. 109-112)

frequently altered to meet changing demands.

In the case of molding powders especially, a major advantage of proprietary compounding operations is the ability to adjust the opposing factors of shelf life and cure time for optimum cost and operating flexibility. Vendors of epoxy molding powders are generally forced to build in extended shelf life to forestall losses in storage; in most cases this means they must produce slower-curing formulations. Formulating in the plant permits purchase of raw materials which do not have the longer cures associated with extended shelf-lived resins. By using resins with shorter shelf lives, epoxy formulations can be produced as needed which will mold at speeds comparable to those of the fast-curing phenolics.

Equipment

Epoxy molding compounds can be handled in conventional transfer presses. However, significant savings can often be realized by building special, or modifying suitable existing, light-duty presses for molding epoxy encapsulations.

Presses used for the encapsulation of electrical coils at Wabash Magnetics have a maximum clamp pressure of 6 tons, a platen area of about 100 sq. in., and will handle up to 9 oz. of epoxy molding powder per cycle.

Since embedment by transfer molding is essentially an insert molding operation of some complexity, it is desirable either to use loading fixtures to position components to be encapsulated within the mold or to build the mold with interchangeable sections so that one section may be loaded while the duplicate section is in the press during the molding cycle.

Molds are constructed according to the standard design practices used in the building of molds for thermosetting resins. However, experience has shown that attention should be paid to the following mold design considerations:

1. Parting lines and other mating surfaces should be machined to tolerances within 0.001 in. since epoxies have very low viscosities prior to curing and excessive flashing may be experienced between poorly matched mold surfaces. Since abrasive fillers are often used in the molding compounds to develop desirable electrical properties, heavy flashing will cause excessive mold wear. In addition to the precautions mentioned above, hardened tool steels should be used throughout the mold. Gates should be designed so that they may be easily replaced, or should be made of super-abrasive-resistant materials such as carbide alloys.

Somewhat larger than normal gate and runner sizes are desirable to minimize the amount of molding pressure which will be required. A gate size of 0.003 to 0.005 sq. in. for each gram of compound required to fill the cavity works well with formulations similar to that shown in Table III.

Molds should be adequately vented in one or more places to assure void-free parts. Unimpregnated coils and components usually have a considerable amount of air

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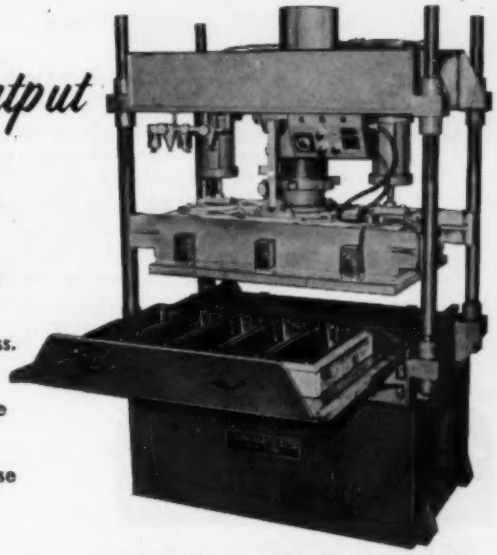

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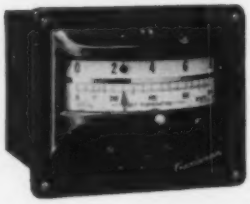

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occluded within them, between coil windings, etc., which sometimes poses molding problems. This problem is somewhat alleviated by preheating the part before molding. Preheating of the component may also be used to shorten the molding cycle, as does preheating the molding compound. Individual compound preformers and preheaters can be conveniently located near the press.

The processing equipment used in the casting of resins as well as operating techniques is adequately covered in the literature (5, 6, 7) and needs little elaboration here.

Economics

In general, total tooling costs and capital equipment costs for molded encapsulation processes are at least as high, if not higher, than those associated with the casting process. However, it must be remembered that much of the initial cost is of a depreciable nature and may or may not play an appreciable part in determining unit costs.

The tooling used for the transfer molding of encapsulations, as indicated above, is usually made of precision-machined hardened steel. This type of tooling is generally more expensive than the die cast or pressure cast aluminum tooling that is used in epoxy casting operations. Although a greater number of casting molds might be required (see Fig. 2, p. 112), the total cost of the several molds is usually lower than that of a much smaller number of transfer molds.

However, the molds or tooling for the molded encapsulation process are generally of much higher quality, capable of producing parts with superior appearance and closer dimensional tolerances.

Another advantage of the molded encapsulation process over that of casting is that sprues and runners can often be made much smaller on molded components. In addition to possible savings in material, parts generally have a better appearance and finishing operations are minimized or eliminated.

Mold release requirements are sharply reduced or eliminated in the molding process, as opposed to the need to use silicone release in casting encapsulations. The purchase of release agents is a considerable expense in large-volume

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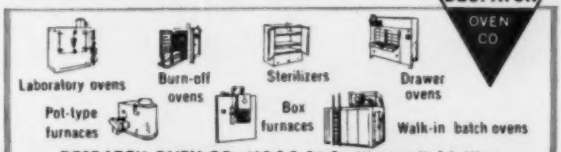

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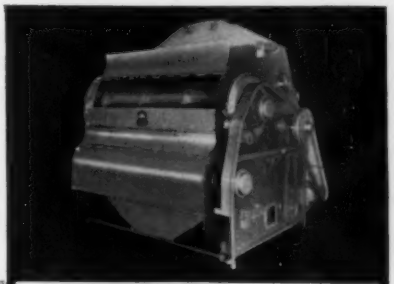

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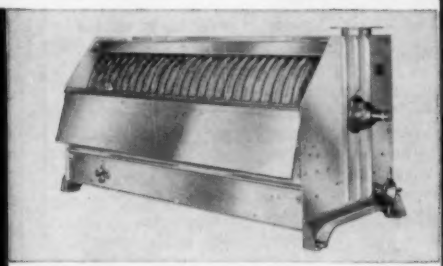

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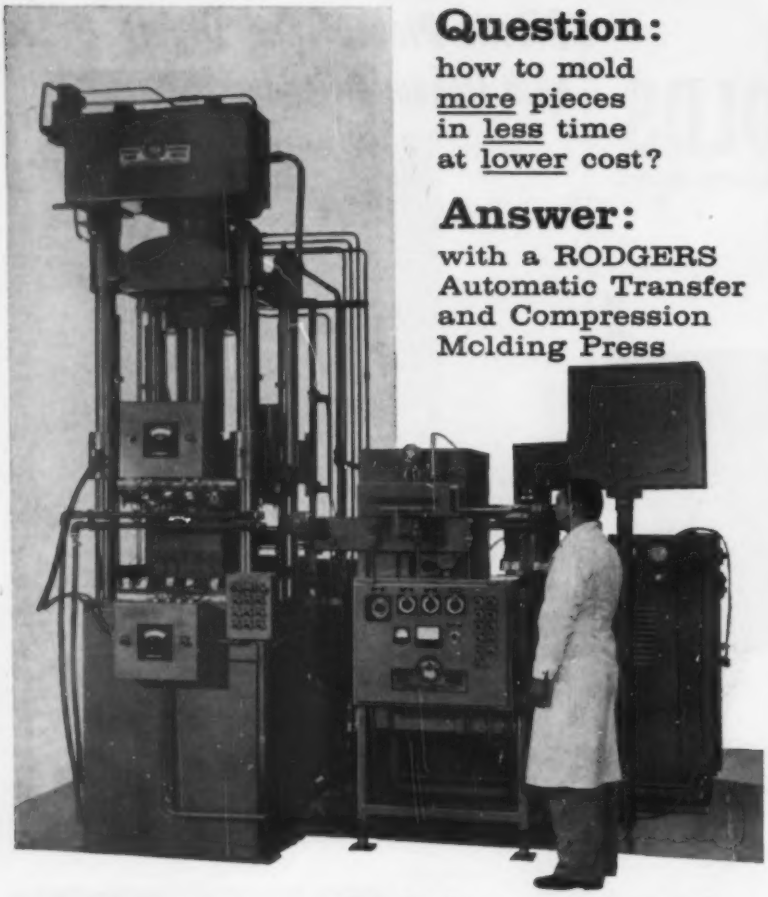

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casting operations. In addition, release agents sometimes adhere to the parts or cause other problems.

Large components to be encapsulated present problems whether molded or cast. The release of exothermic heat and shrinkage are the major problems experienced in casting. Press size appears to be the limiting factor in encapsulation by molding. Since most large components are generally ordered in small quantities, it is hard to justify economically the higher tooling charges associated with molding; casting is usually the most economical method of production.

After initial start-up operations, experience has indicated that scrap losses have averaged about 40% less in molding operations as opposed to casting operations. This is probably due to the fact that it is easier to control temperature and other processing variables in transfer molding since the control of these parameters is centralized at the press. In addition, operator responsibility is easier to pin-point, and quality-control checks on the molding powder are easier to maintain on batch-mixed materials than on the continuously mixed, fast-setting, casting formulations.

To illustrate the source and the magnitude of costs in the encapsulation processes and to indicate the savings possible, the costs associated with the production of two types of coils produced by both types of processes are presented below. Both of these coils are now being produced by molding techniques because of the economic advantage of this process.

Tables V and VI, p. 111, present the capital equipment and tooling expenses necessary for two different encapsulated coils, "A" and "B". From the data, the total initial investment required for Coil B is slightly lower for molding; the total investment for Coil A is considerably higher for molding. Although this indicates an increase in the fixed charges per unit for the molding process, savings in labor, as shown below, largely offset this and result in a net saving.

For Coil A with a production rate of several million pieces per year, the direct labor involved in casting 1000 coils was 8.27 hours. When transfer molded, direct labor dropped to **(To page 226)**

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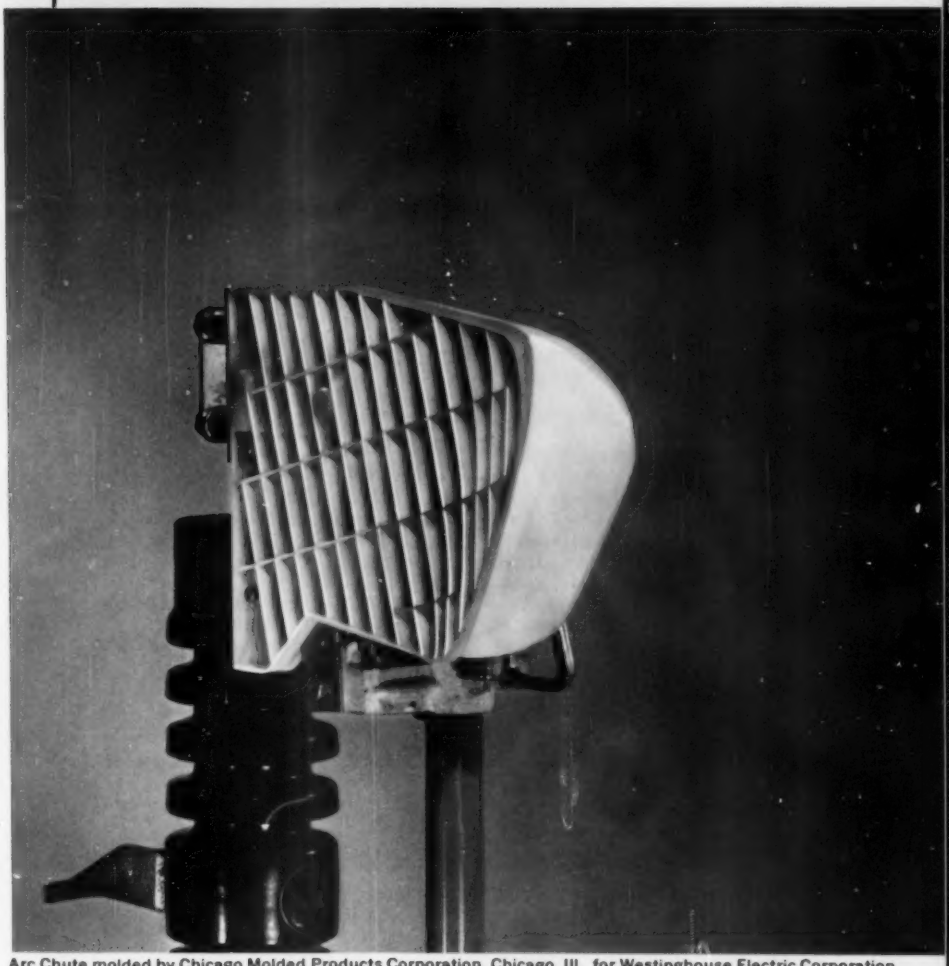

Arc Chute molded by Chicago Molded Products Corporation, Chicago, Ill., for Westinghouse Electric Corporation

Significant advance in load-break design made possible by using DELRIN® for arc chute

New electrical cutout device features a self-contained load-break, designed to permit repetitive interruptions of high load currents throughout its life without maintenance or replacement of parts (such as fuse links and gas bottles). The significant advance in design is made possible by the use of Du Pont's DELRIN acetal resin for the arc chute through which the contact blade is pulled. Load-break operation is achieved by lowering the knife switch between the facing grids of the chute away from the contact points. The normal arc is quickly extinguished (less than 0.1 second) by a de-ionizing gas generated inside the chute from the resulting arc heat.

The arc chute of DELRIN lasts the life of the cutout, is safe and reliable. Units have been tested for 200 load-break operations at 200 amps, 15KV with a circuit power factor of 70% or higher. Inspection showed negligible wear, only very slight discoloration and no evidence of carbon tracking.

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See the next page for more examples of what DELRIN is doing to improve products and reduce costs.

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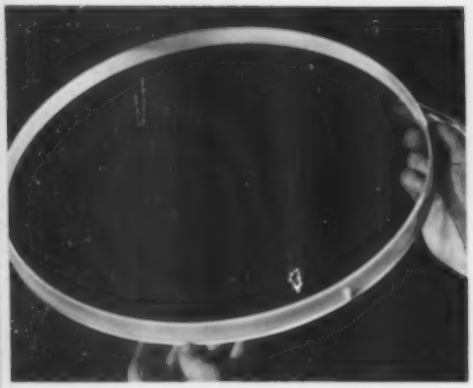

This molded ring of DELRIN is key unit of a simplified bearing system for the revolving drum of an RCA Whirlpool dryer. The bearing design requirements, which led directly to DELRIN, included excellent frictional properties, abrasion resistance, dimensional stability and retention of physical properties in a moist atmosphere at temperatures up to 200°F., and freedom from warpage. (Molded by Haas Molding Co., Mendon, Michigan, for Whirlpool Corporation, St. Joseph, Michigan.)

DELRIN has replaced an expensive two-piece, spot-welded and copperplated, stamped-steel component in fluorescent light-starter switch. The new one-piece injection-molded part is used as a lock spring. DELRIN acetal resin is a good electrical insulator, has excellent resilience, which gives it the spring-like properties needed here, wear resistance and dimensional stability; costs about half of previous metal component. (Molded by Waterbury Company, Waterbury, Connecticut, for Edwin Gaynor Co., Bridgeport, Connecticut.)

A clamp-on hand brake for cotton spinning spindles uses DELRIN for the handle, the cam and two brake arms. The flexing arms of tough, resilient DELRIN provide automatic adjustment and take-up for wear. DELRIN is easily molded in the complex shapes required, eliminates the need for machining operations. (By Brook Molding Company, Norwood, Mass., for Whitin Machine Works, Whitinsville, Mass.)

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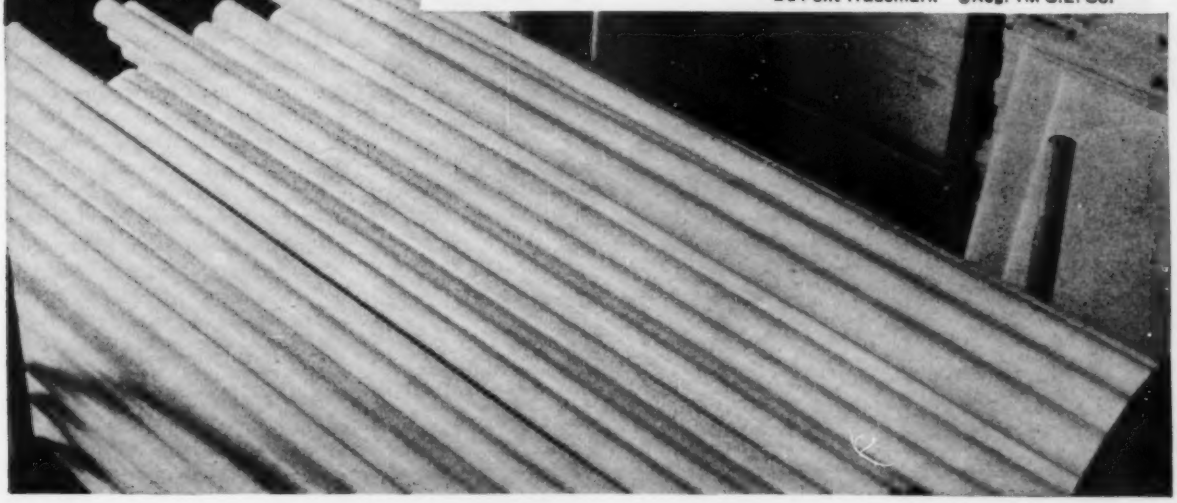

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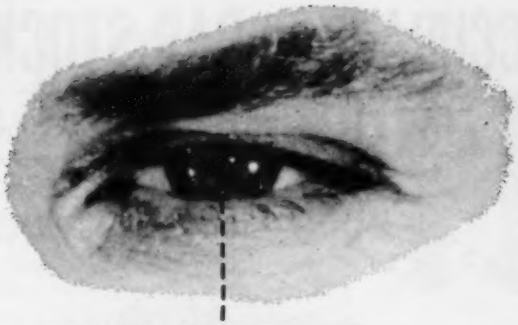
2.45 hr./1000 coils. Each operator ran two presses with eight-cavity molds on a 1.8-min. overall cycle. This represented a labor saving of 5.82 hr./1000 coils or savings in direct labor of about 70 percent.

Coil B has a total production volume of about 200,000 pieces per year. Because automatic mixing, dispensing, and mold opening were not used in casting this coil, a somewhat lower capital expenditure was required. However, labor ran 21.88 hr./1000 coils. A four-cavity mold was used for transfer molding employing a cycle similar to that used for Coil A, which allowed a reduction in labor required to 9.12 hr./1000 coils, or a reduction in direct labor charges of approximately 58 percent.

To illustrate how the labor savings can offset the increased investment which may be required and result in a net cost saving, Table VII, p. 112, presents a summary of those costs which differ significantly between the two methods. To develop the costs, reasonable assumptions were made regarding the depreciation of capital equipment, amortization of the tooling costs, hourly labor rates, utilization of the equipment, and yearly production volume. These parameters will, of course, differ from plant to plant; however, the data presented indicate the order of magnitude of the savings involved. Savings will probably be higher than shown, since a conservative hourly labor charge was used and labor overhead is not included.

No charges for molding or casting compound are shown. Molding compound is about 25% more costly on a volume basis than a casting resin. However, depending on the component, most or all of this difference is recovered since less resin is wasted in the gate and runner of the transfer-molded coil than in the pouring and evacuating sprue of a cast coil. Also the loss of resin in mixing containers, purging the casting dispenser, etc., is eliminated. Thus, in the calculation, material costs were assumed equivalent and omitted since they would not affect the savings.

As shown in Table VII, Coil A was estimated to be about 50% cheaper to produce by transfer molding than by the casting method. Coil B was about 45% cheaper



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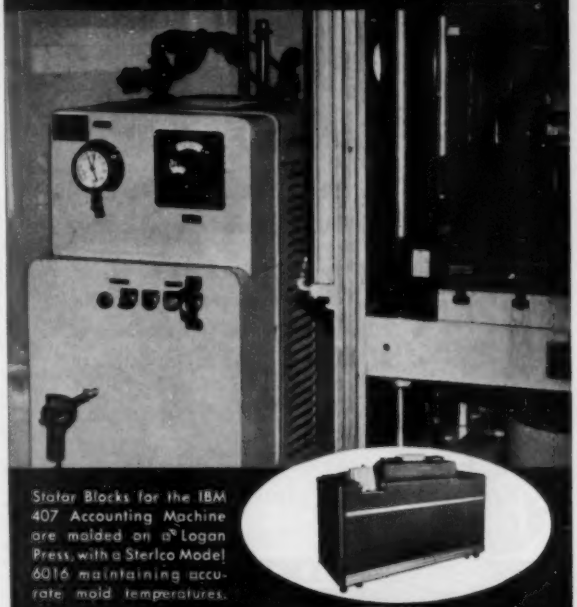

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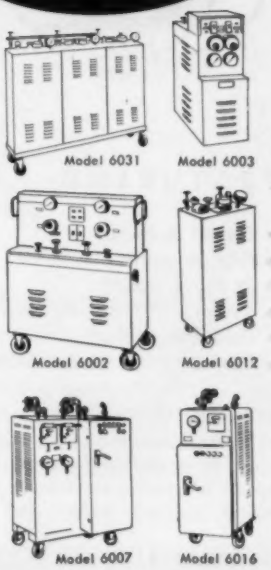

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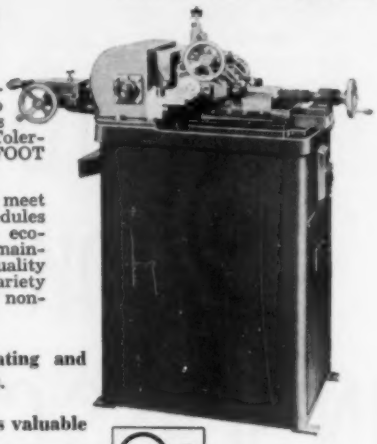

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per unit of 1000 coils. The total saving for the volumes of production are shown in the table.

Experience strongly indicates that when volume requirements equal or exceed about 100,000 pieces/year, direct labor savings of at least 50% can be achieved by transfer molding epoxy encapsulated components instead of casting or potting them. Since the labor cost is the largest unit cost, it generally will result in an over-all unit cost saving, in spite of the additional tooling costs associated with molding.

Experience has shown that, to obtain maximum efficiencies, it is necessary to have engineering facilities capable of developing part, equipment, and compound as a unified package. Naturally, this does not mean that a complete development project is necessary for every new part, but the "package" concept and capability must be present for the best results.

Obviously the above conclusions are predicated on the production requirements as well as other technical requirements and do not apply in every single case. Each application will have to be evaluated on its own merits and peculiarities. However, when applications permit, transfer molding should be seriously considered as one of several methods of production.

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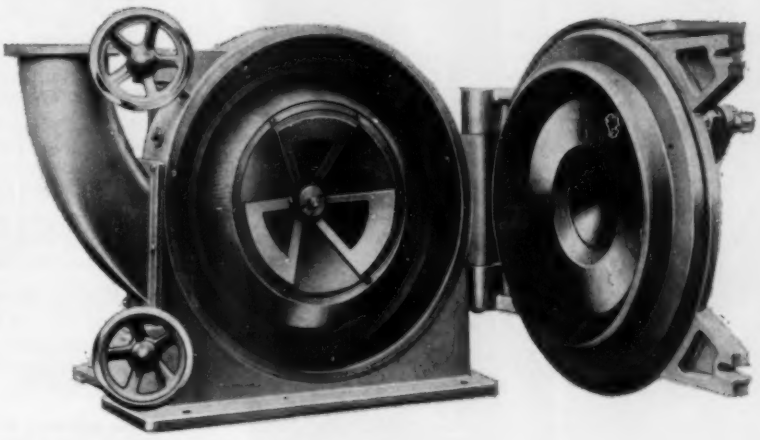

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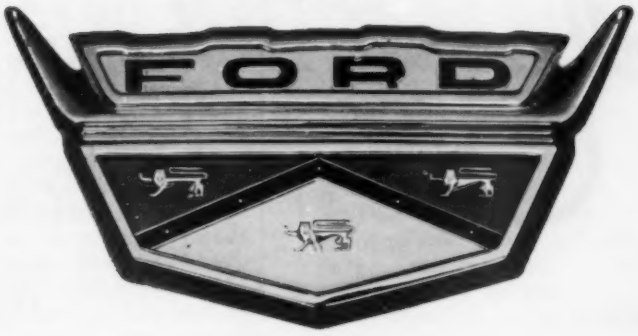

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Melt elasticity

(From pp. 116-130)

and melt temperature for three types of commercial polyolefins examined in the experiments. These results clearly indicate that as the rate of strain application is kept constant, the amount of elastic recovery diminishes as both the temperature and initial strain magnitude are increased. Specifically, the lower the temperature, the more elastic are the melts, at a given strain; or the lower the magnitude of strain applied, the higher the elastic recovery for any given temperature. This type of behavior is readily explained by the basic theory discussed earlier on molecular structure and viscoelastic behavior when strain is applied to a polymer melt. The closer the melt temperature is to the crystalline melting point (that is, at lowest melt temperatures as determined by loss of birefringence), the more readily observed and more pronounced is the nearly instantaneous elastic compliance of the melt as shown by the high recovery values in these experiments. Also shown by these curves is the importance of the time-dependent elastic recovery (retarded elastic compliance) of the polymer chain network structure. Due to the shortness of the strain application period for small degrees of strain, the polymer chains as a whole do not have sufficient time to respond to the total load applied. This results in deformation occurring primarily on a small local scale and leaves the bulk of the network structure undisturbed so that its elastic behavior is essentially unchanged. For higher degrees of strain where the time of loading is longer, the total strain is distributed over the entire network resulting in relaxation of part of the structure as the chains uncoil past the entanglement points and orient themselves in the direction of stress. This explains why less recovery is observed for large magnitudes of strain and for slower straining rates. Generally, small degrees of strain and rapid straining rates favor the response of elastic recovery mechanisms.

Figs. 4, 5, and 6 also indicate that the elastic recovery of the branched materials is affected more by temperature than the linear ma-

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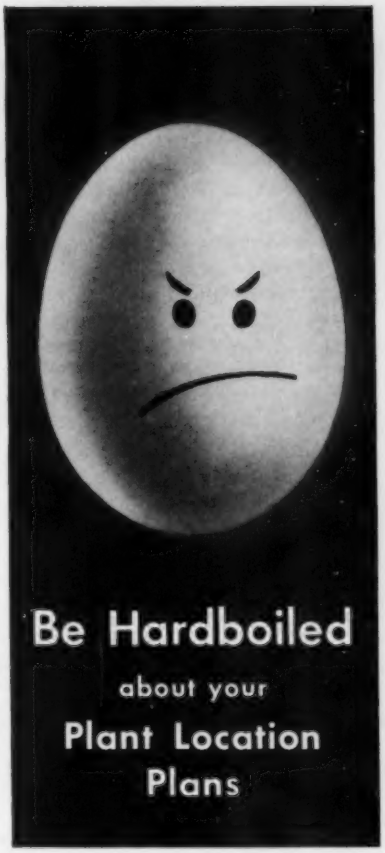
terial. This is suggested by the relatively wide separation of the constant temperature recovery curves for the branched polymers and the relatively narrow range for the linear polymer. If a given magnitude of strain is selected and the corresponding recovery and temperature data is plotted for these three basic materials, as shown in Fig. 7, p. 124, a very distinct difference in the elastic behavior with temperature is detected. This complex picture can be resolved by consideration of the temperature dependency of these structurally different materials. These data suggest there is possibly more than one elastic recovery mechanism operating in the temperature range investigated. At temperatures below 400° F., we see the normal type of behavior for these materials. That is, the branched materials generally are more or equally as elastic as the linear material due to the high degree of localized entanglement of the branches. At temperatures above 400° F., the linear polymer maintains a relatively constant decay of elastic recovery where the branched materials show a marked decrease in their elastic recovery characteristics. If we examine the structural mechanism that is involved, a reasonable explanation of this condition can be developed.

In the over-all structure of highly branched polymers, there is relatively little long-chain entanglement. Rather there is principally only localized entanglement and/or interlocking of the branches protruding from the main polymer chain. The main polymer chain is fairly short and can not loop and coil around itself and its neighbors, due to its shorter length and the steric hindrance produced by the branches. This type of entanglement and structure exhibits a significant elastic response only at relatively moderate temperatures where the structure is closely packed and the secondary bonds are strong. At higher temperatures the structural pattern is more disturbed, decreasing branch entanglement, leaving only weakened secondary bonds and the small amount of long-chain entanglement present to promote elastic recovery. This structure is in agreement with the lower value of crystallinity (den-



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sity) observed at ordinary temperatures in branched materials.

The structure of linear polymers is considerably different. Here there are essentially no side branches and the main polymer chain is many, many times longer. Due to the favored Gaussian distribution, these chains loop, coil, and enmesh into an interlocking network structure, which results in a highly interwoven network system in which the internal structure does not change appreciably with increasing temperature, due to the semi-permanent entanglement points which are distributed over a wide area. Due to the linearity of these chains, conditions are favorable for possible crystallite growth in the melt, producing a semi-crosslinked structure which is combined with chain entanglement. Thus, when a strain is applied to such a system, it is distributed over the many points of entanglement and the transient, rigid crystalline areas between chains. This results in a different kind of elastic response than is the case for the more amorphous branched materials. As discussed earlier, crystalline regions in branched polymers occur in lesser amounts than in linear polymers, and this is the reason why this particular mechanism does not contribute greatly to the elastic behavior of branched polymers. It is, however, very pronounced for linear polymers. As we go up the temperature scale, the interchain distances increase and the secondary bonds decrease in strength. This increased distance lessens the overall entanglement effect of the side groups in branched materials, leaving only the relatively low amount of entanglement of the short main polymer chains for supporting strain and giving elastic recovery at the higher temperatures. In the case of the linear polymer, which has essentially no elastic response arising from side-branch entanglement, it is principally only the main chain coiling and entanglement mechanism that operates over the entire temperature scale. This produces the essentially linear elastic behavior with increasing temperature, because of the less drastic change of the internal molecular structure. In both of these materials at lower temperatures, there is an apparent increase in elastic response evidenced by change in the slope of the curves. This behavior is considered to be due mainly to increased influence of transient crystallization occurring in the melt, which produces a simulated crosslinked network. This molecular response mechanism adds to the main mechanisms, which are discussed in the preceding paragraph. As previously suggested, this mechanism possibly contributes to the elastic response of the linear material at high temperatures, but, apparently, contributes very little to the high temperature elastic response of the branched materials.

Fig. 8, p. 124, shows the recovery data as a function of methyl groups (branching) for various branched and linear polyethylene polymers run at the same low temperature, but at different magnitudes of strain. It is shown from these data that the linear polymers generally display more elastic recovery behavior than the branched polymers. However, within the branched

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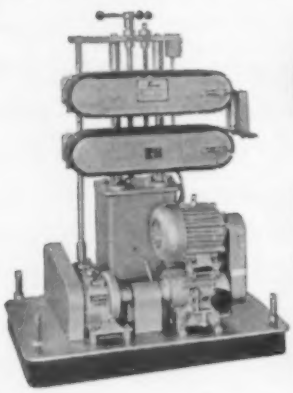

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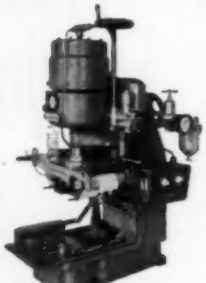

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polymer, these curves clearly indicate that as the degree of branching increases, the elastic behavior also increases. Also, it is indicated that as the methyl branches are decreased in either the branched or the linear polymers, the less is the elastic response due to the smaller amount of branch entanglement contributing to elastic recovery at this particular temperature. These last two observations further substantiate the two different recovery mechanisms previously discussed.

Fig. 9, p. 126, plots the recovery data as a function of weight average molecular weight, M_w, for a series of branched and linear polyethylenes run at the same temperature, but at various degrees of strain. It is evident from these data that as the molecular weight decreases, the polymer melts exhibit less elastic recovery at a given strain magnitude. This is also true for increased strain magnitude at any specific molecular weight. It is evident that increasing the molecular weight beyond a given point does not appreciably increase the elastic characteristics. On the other hand, molecular weights below a given level produce polymers which exhibit considerably less recovery. This is an apparent indication that polymer chains must reach a minimum molecular weight before enough long-range chain entanglement will occur to produce high elastic recovery. But once a certain length is obtained, there is very little additional increase in effective network entanglement. This adds support to the previous explanation why linear materials respond by different structural means than do branched materials.

It is significant that the molecular weight curves do not pass through the origin for the family of linear materials. Thus, one might conclude from these data that it is necessary to have polymers with molecular weights greater than 60,000 to 75,000 before the melt can exhibit elastic behavior and partially support strain rather than exhibit only viscous flow. From these data, it is again evident that linear polymers display greater elastic behavior than branched materials of corresponding molecular weight.

Fig. 10, p. 126, shows the recovery data as a **(To page 238)**

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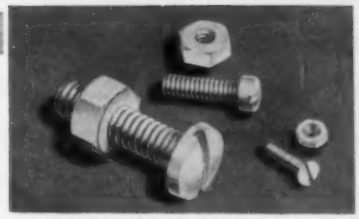

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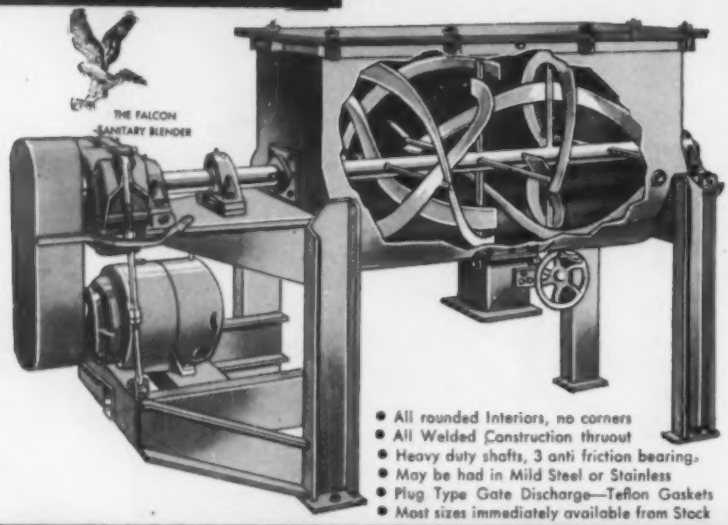

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function of time for two molecular-weight linear polyethylene samples of the same type. Note that molecular-weight greatly influences both the total amount of recovery and the duration of the recovery period. The lower-molecular-weight polymer recovery period extends over four log cycles of time before elastic recovery ceases, whereas the high-molecular-weight polymer extends its recovery period over five log cycles of time. The logical explanation for this behavior is that the network entanglement is spread over a much greater volume in the high-molecular-weight material, and takes longer to respond than the low-molecular-weight material. The differences in the slopes of these curves indicate the action of the recovery mechanisms must be greater for the high-molecular-weight material. Consequently, the elastic response rate to a given deformation would be faster for a higher-molecular-weight material than for a low one.

Fig. 11, p. 130, shows the recovery vs. temperature data recorded at various strain levels for a 3-M.I. Phillips-type linear polymer that is different than the 0.6-M.I. Phillips polymer shown in previous figures. In addition to the normal behavior with temperature expected for linear polymers, the curve actually doubles back at temperatures over 400° F. These curves indicate that this material recovers almost as much at 450° F. as it does at 300° F. It is obvious that, in this particular polymer, there is some temperature dependent mechanism producing more elastic recovery at these higher temperatures than in the other linear polymer examined, and no definite explanation can be offered for this particular behavior. This behavior is apparent at all the values of strain investigated with this material. The two Phillips polymers involved are representative of distinctly different molecular-weight ranges within the same family of polymers, as is indicated by the large differences in their melt indices. Perhaps the 3-M.I. polymer has an extremely narrow molecular-weight distribution. This then may be the typical behavior of linear polymer of narrow molecular-weight distribution, due to the combined behavior of the previously

discussed molecular mechanisms, but which are further enhanced by the influence of a narrow molecular distribution.

Fig. 12, p. 130, shows the composite elastic recovery data for a branched and a linear polymer recorded at the same strain magnitude over the full temperature range investigated. In addition to the instantaneous elastic recovery data previously shown, both the 5- and 10-sec. delayed elastic recovery data are plotted. It is readily apparent that maintaining the melt under constant strain for any length of time produces a large decay in the elastic response mechanisms. This is due to the time-dependent mechanisms previously discussed, and results from the greater degree of slippage of the polymer chains and branches around the points of entanglement producing an overall stress relaxation phenomenon under constant strain.

Conclusions

1. Polymer melts exhibit high elastic recovery characteristics for values of strain when the external strain is rapidly applied.

2. The lower the magnitude of strain, the higher is the elastic recovery of the melt at any given temperature for both branched and linear polyolefins.

3. The closer the melt temperature is to the crystalline melting point, the more elastic are the melts of both branched and linear polyolefins.

4. Linear ethylene polymers exhibit more elastic recovery at temperatures above 400° F. than branched ethylene and propylene polymers when subjected to the same conditions of strain due to different mechanisms involved.

5. There appear to be two distinctly different strain recovery mechanisms contributing to the elastic response of branched and linear polyolefins which are: (a) polymer chain coiling and looping (a long range entanglement); and (b) side branch chain intermeshing (short range entanglement).

Principally, it is the former mechanism which controls the elastic recovery behavior in linear polymers and it is the latter mechanism which governs the elastic behavior in branched polymers. The short-range entanglement of side

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branch chains is very temperature dependent, resulting in less elastic recovery in branched polymers at high temperatures. The long-range entanglement of the main polymer chains is not affected as greatly by temperature. This is the primary reason why the elastic behavior of linear polymers is essentially temperature independent over the fabrication temperature range.

6. At low-melt temperatures, an increase in methyl groups generally imparts greater elastic recovery properties to the melts of polyolefins. However, at higher temperatures, an increased number of methyl groups does not produce an increase in elastic recovery.

7. The elastic characteristics of polyolefins are very dependent upon molecular weight. Polymer chains must be of a sufficient length to give the proper degree and type of entanglement before polymer melts can exhibit high degrees of elastic recovery.

8. Imposition of long periods of strain upon polyolefin melts result in almost complete destruction of the elastic recovery mechanisms due to the disentanglement and/or rupture of the polymer chains producing the elastic responding network structure.

9. Included in the overall scope of considerations for "ideal" converting of polyolefin polymers must be the time, temperature, and strain-rate dependency of the elastic behavior parameters of the melt. Thus, for uniform control of the cross-section dimensions of extruded shapes and injection molded parts, a fabricator must allow sufficient time for the retarded elastic mechanisms to respond to a reasonable state of equilibrium before "freezing-in" these time-dependent forces by cooling. Also excessive working of polymer melts at high strain levels and for long periods of time causes relaxation of the elastic responding mechanisms, and will lead to mechanical degradation, which results in altered end-use physical properties.

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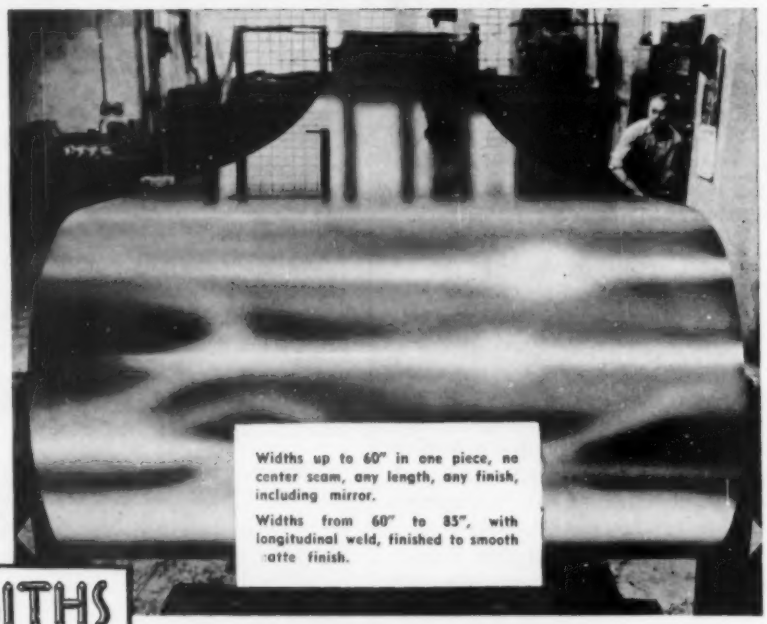

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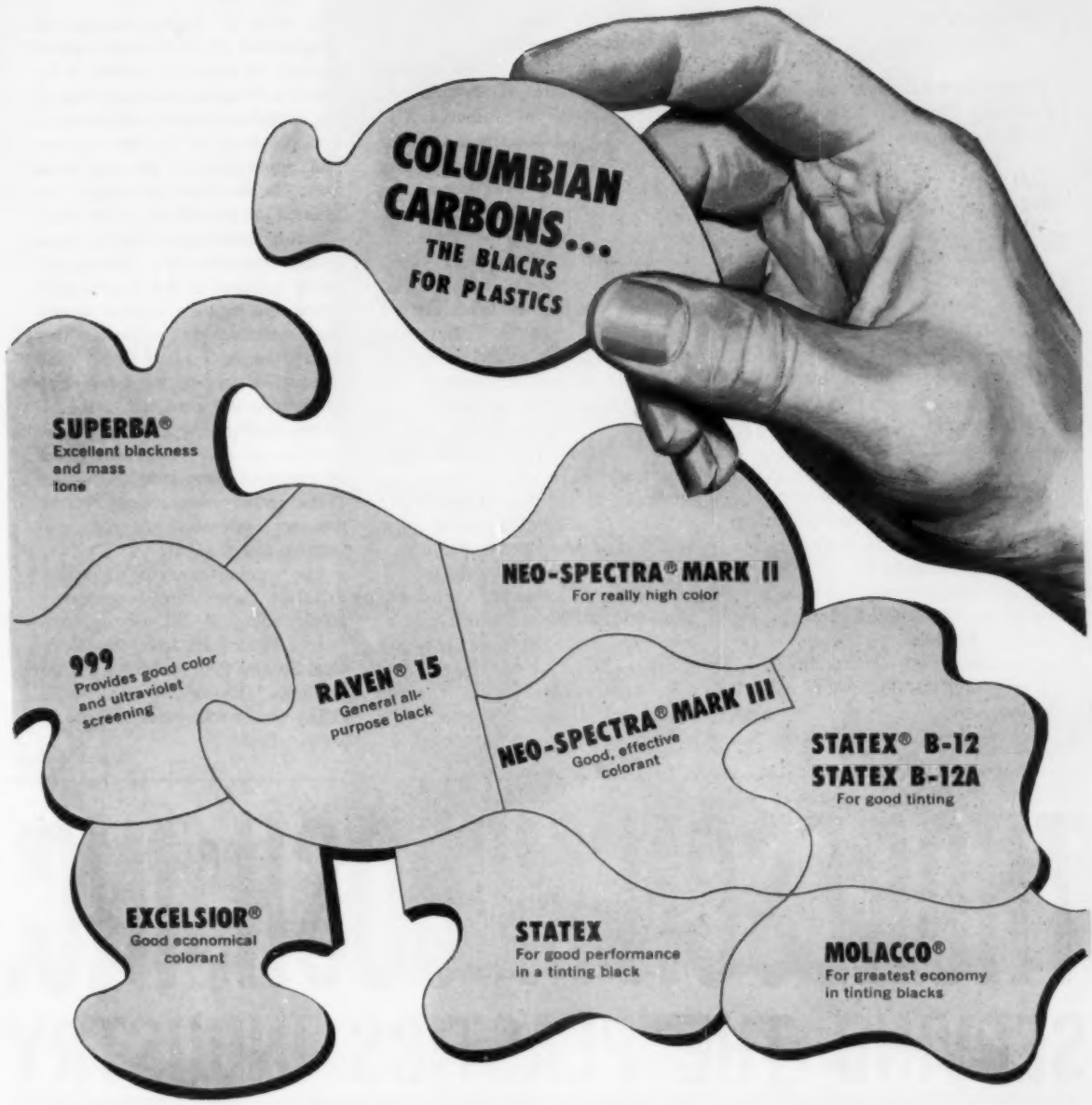

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25 years

(From page 139)

Dow Chemical, Eastman Chemical, General Electric, Monsanto Chemical, Rohm and Haas, and Union Carbide. Many others have contributed reports of important developments in their laboratories, including some companies that have only entered the field within the past decade.

The plastics industry has benefitted greatly from the basic and unbiased studies of the chemistry and properties of plastic materials conducted in government, university, and research institutions. The Technical Section has continuously provided a forum for disseminating this kind of valuable information to the industry's engineers and scientists, who have used it to the advantage of all concerned.

The contributions from the government laboratories have originated about equally in the U. S. Departments of Agriculture, Commerce, and Defense. Many universities have participated in these basic investigations of plastics; the names of William N. Findley of Brown and Illinois; A. G. H. Dietz and Fred McGarry at the Massachusetts Institute of Technology; Bryce Maxwell at Princeton; V. Stannett at Syracuse; and Herman Mark at the Polytechnic Institute of Brooklyn are among the professors who have authored notable papers published in the Technical Section during the past 25 years.

This forum has also been utilized to bring outstanding work abroad to the attention of the U. S. industry. Among the countries represented by authors of papers in the Technical Section have been Brazil, Canada, France, Germany, Great Britain, Holland, Italy, and Sweden. The work of N. A. de Bruyne on structural properties and epoxy adhesives, of Giulio Natta on the synthesis of stereospecific polymers, of Otto Bayer on polyurethanes, of W. Reppe on monomer syntheses, and of Fritz Feigl on identification tests are some examples of the noteworthy foreign developments that have been covered from time to time in the Technical Section.

Your editor has endeavored during these 25 years, through the preparation of reviews and special reports, to keep the readers of the Technical Section informed regarding significant technical advances and problems in the development and application of plastics materials. He has been encouraged and assisted in these efforts by the many generous expressions received from readers regarding the interest and value to them of the papers published and by their helpful suggestions concerning subjects that needed to be treated. Any small measure of service that the Technical Section has rendered to the industry during these 25 years can be ascribed to the whole-hearted cooperation of many individuals—authors, industry executives, public relations officers, editorial colleagues, and *readers*.

The publishers of MODERN PLASTICS have printed separately a chronological list of approximately 70 articles from the Technical Section that are on the record as "firsts." This listing is available to any reader who cares to write in for it.—**End**

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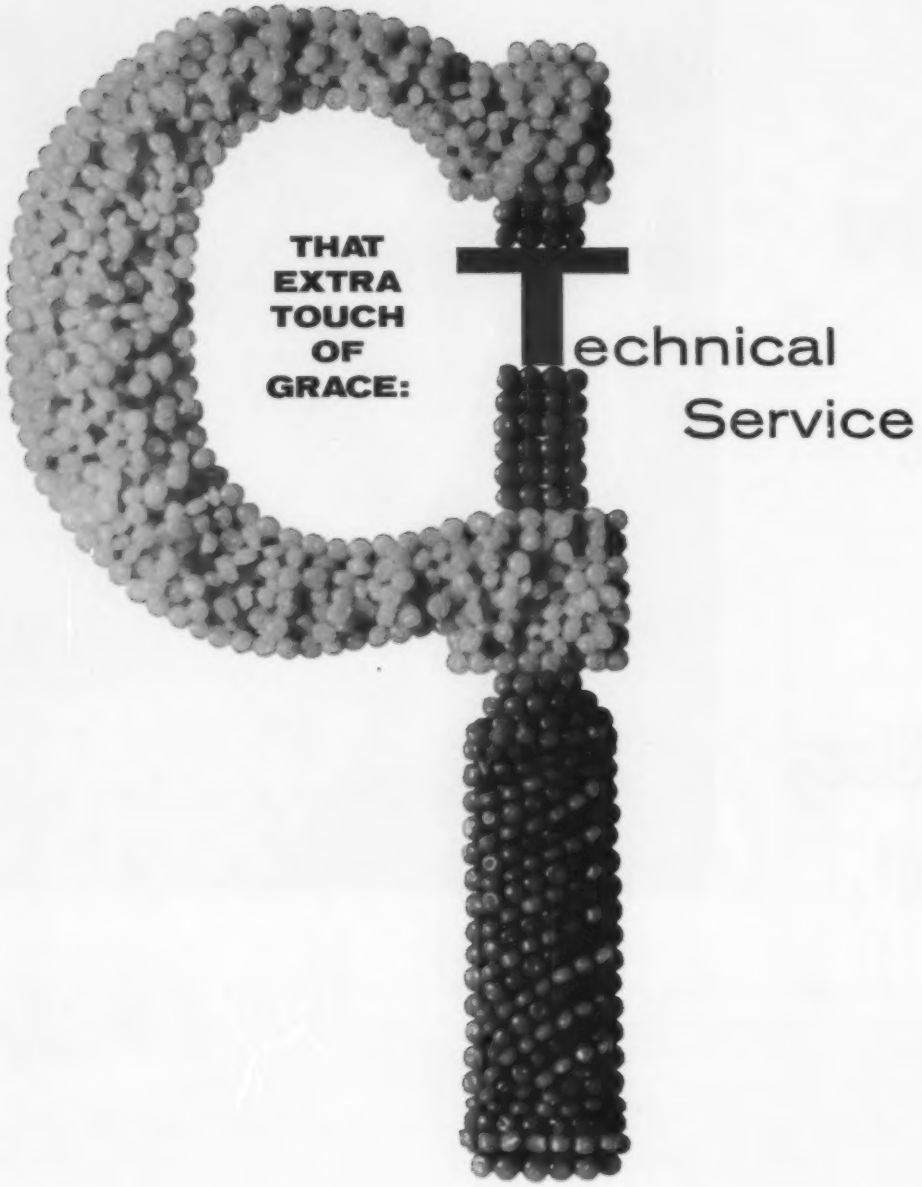

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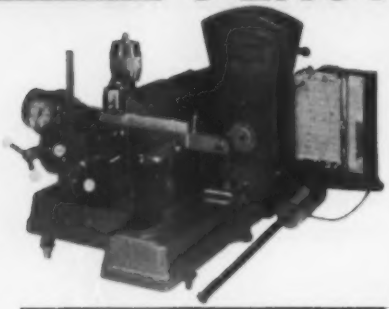

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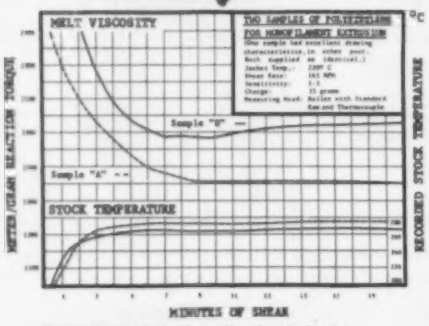

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Thermal properties

(From pp. 140-153)

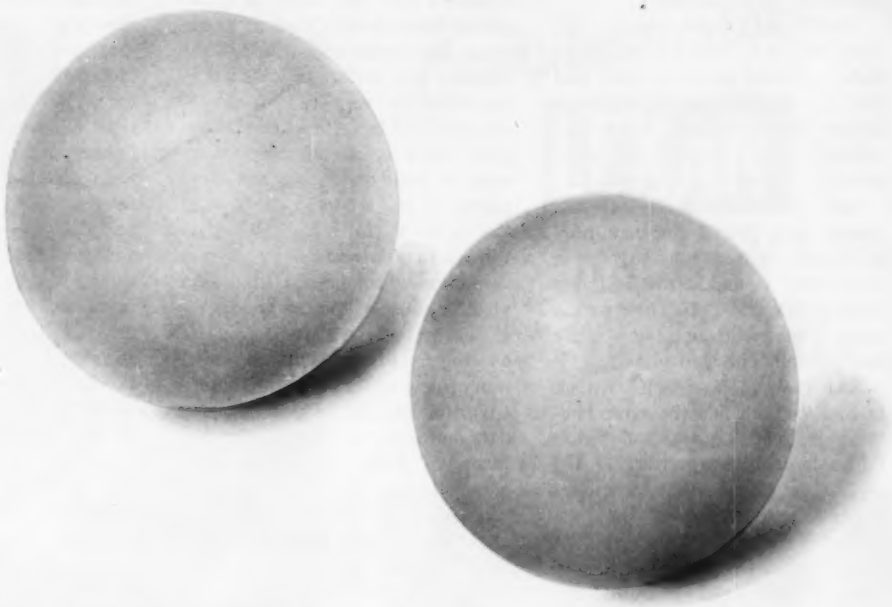
similar to the normal behavior of the resins in the other panels.

From a study of the conductivity of panels SRI 2, 4, 6, 7-1, 8-1, 9, and 11, it appears that the different types of phenolic resins and their cures can result in a wide range of conductivities. The fillers, such as chopped glass and glass weave in panels SRI 2 and SRI 11, with about equal conductivities, seem to have less influence than the history and chemistry of the resin.

Similar observations can be made for the epoxy resins. Panels SRI 1-1 and 1-2 had the same density, contained epoxy resins with the same cure, and had the same filler with different layup. The conductivities were about the same. Panel SRI 12 was denser, contained a different epoxy, and was subjected to a more severe cure. Its conductivity was higher, probably as a result of the different resin and higher density. It is doubtful if the filler contributed to the significant difference. The harder cure should have reduced the value.

The program was not tailored to evaluate the influence of the different resins on conductivity, so that precise observations are not possible. From a study of the data on panels SRI 5, 11, and 12, it appears that at the lower temperature range up to 300° F., the epoxy contributes to a higher conductivity with decreasing values for phenolic and silicone. Oglesby previously noted decreasing conductivities for epoxy, silicones, and phenolics. The value for the epoxy is consistently higher, but the variations in specfic chemistry, density, cure, filler, etc. may alter the position of the silicones and the phenolics.

It seems probable that a thin laminate should possess a lower conductivity than a thicker laminate, as determined in the ASTM apparatus, because the film coefficients at the faces of the panels would constitute a larger part of the total measured temperature drop across the specimen thickness. Undoubtedly, a small film coefficient does exist in some cases. However, the data obtained in this work (⅛ to about ¼ in. thickness) do not confirm this postulation for heat flow normal to the



John Wesley Hyatt never read MODERN PLASTICS, but he had a lot to do with putting us in business. Before we were born (or you, for that matter) ... when billiards were booming but elephants were not, he replaced scarce ivory with a something called "celluloid." John's was the itch that spread to become the boom industry of the 1900's; ours was the scratch that started a bright, new magazine to serve it ... and we've shared a happy, hectic life together for 35 years. Today, there are at least 25 basic plastics, more than 50,000 formulations of a single plastic, the billiard ball has blossomed into 6½ billion lbs. of plastic products and parts annually ... but that same one magazine is still as bright and new and indispensable as ever. John Wesley Hyatt didn't read MODERN PLASTICS, but today most of the men of his mold who are working new wonders with plastics *do*, from raw materials producers to end-users. **MODERN PLASTICS**

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layup, although the data must be considered as inconclusive.

SRI 12 had a higher conductivity than SRI 1-1 and 1-2, although both contained an epoxy resin and SRI 12 was thinner. SRI 12 was denser (reinforcements were also different), so density probably biased any notice of thickness.

SRI 11 was both thinner and denser than SRI 2 but had only a slightly higher conductivity at above 300° F. and actually a lower value at below 300° F. These panels were a phenolic-continuous glass and phenolic-chopped glass.

SRI 11 was about half as thick as SRI 9 (both had the same phenolic resin but glass and nylon reinforcements, respectively). Up to 200° F., both had the same conductivity. Above 200° F., the thicker nylon had a lower conductivity but it also had about half the density and the nylon probably started to decompose, so that a firm conclusion is not possible. If dependent on thickness, these data would refute the expected effect.

If thickness does have an influence on the thermal conductivity, it must be a relatively small order influence over the range of thicknesses investigated. Other more obvious parameters appear to control. Oglesby did report a lower conductivity for very thin laminates of about 0.036 in. thickness; however, there is considerable difference in both measuring and comparing in the 0.036 to ⅛ in. and the ⅛ to ¼ in. ranges. His data were also confounded by density variations which he discussed as a possible cause of the differences.

Because of the modifications to existing requirements and the creation of new applications in different environments, the need for thermal data increases. To meet the requirements of these new applications, old materials are being changed and new materials are being created. Many applications in which these materials will be used require accurate thermal data.

Among the new materials are filament-wound structures used in rocket cases, graphite cloth impregnated with resin, and metal and ceramic cloth and fibers impregnated with resin. There have been relatively recent changes in the formulations of resins to increase their upper temperature limit. Also, there have been changes in manufacturing procedures, including cures and postcures. These variations all have an unpredictable influence on the thermal properties.

In addition to new materials, new environments require that thermal data be obtained that will be applicable. Steady state values are often used in transient heat flow equations, undoubtedly resulting in errors because of the inability to accurately define the boundary conditions. Dynamic values should be obtained for these equations until the transient and steady state conditions can be more adequately related. Many of the new plastics applications will be in outer space. Thermal data to be used in the design of such equipment should be obtained in a vacuum for those properties that can be expected to vary with pressure. As of now, there is no way to predict precise values for the properties when significant changes are made in the material or the application.—**End**

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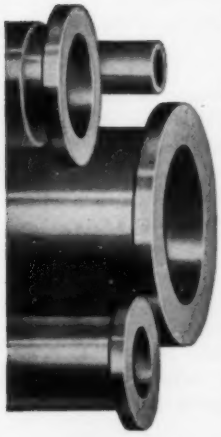

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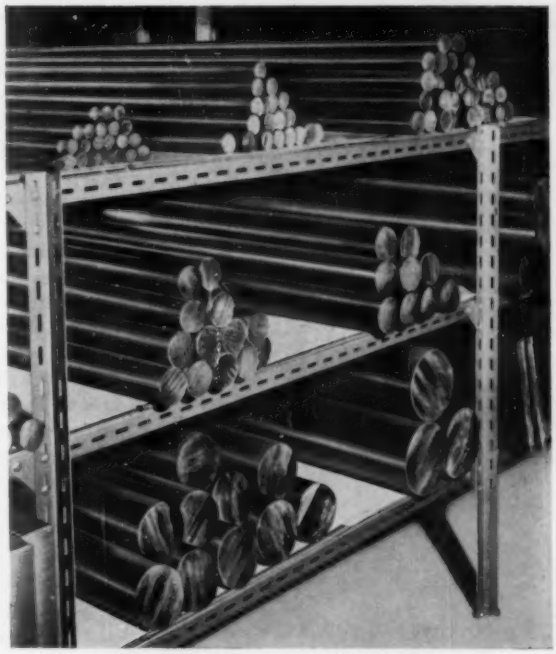

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Stress distribution

(From pp. 154-157)

the variation of stress-optic coefficient for Epon 815 resin that was cured with Curing Agent D as a function of the bulk temperature.

The accurate interpretation of photo-elastic fringe patterns is a notoriously difficult process if one is seeking accurate values of the stresses concerned (2). In the absence of a free surface in the plane of the section it is necessary to determine the elongation pattern of the plastic when it has been relieved from stresses. This, however, did not prove practical with the small castings with which we were concerned; we limited our interpretation to determining the exact values of the shears that occur in the resin. This shear gives a valuable indication of the order of magnitude of the differences of the principal stresses in the resin at the center and at the edge; as each fringe at room temperature represents about 900 p.s.i. in shear per inch length of specimen, we can readily see that the difference in shear between the center of the tricorne and the edge of the tricorne will be about 2500 p.s.i. at room temperature. As the center is symmetrical there will be zero shear stress at the center, so we can say that at the middle of each edge of the tricorne the shear stress will be about 2500 p.s.i.

This shear stress is equal to the difference of the principal stresses at the edge, so that we can point out with some confidence that, as the stresses between the resin and the plastic are tensile, there is at least a tensile stress of 5000 p.s.i. acting on the glass at the center of the sides of the tricorne. This value is undoubtedly lower than is actually the case, however, it is sufficiently large to be consonant with the fact that the resin on shrinking often pulls pieces of glass out of the tubes.

By observing the difference in the fringe patterns as the tricorne is cooled, we can see that the shear increases with decreasing temperature and can be almost totally relieved at about 190° F. which is near the heat distortion point of the resin.

It was suspected earlier that internal strains in the resin might be

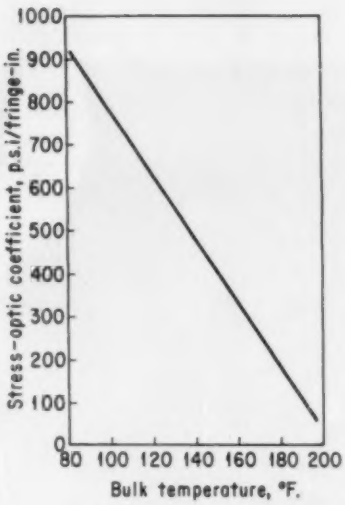

FIG. 10: Stress-optic coefficient of Shell Chemical's Epon 815 resin that was cured with Agent D as a function of temperature.

a result of the polymerization of the resin itself, but it was confirmed that the fringe patterns observed in the resin were due *solely* to the tensile and shear forces from the retaining glass walls by boiling the specimen. This destroyed the bonding with the glass; on the elimination of this bonding we can see from the evidence shown in Fig. 7 that there is substantially no shear stress present in the resin.

Discussion

The interpretation of the photoelastic data shows the following three important points:

1. There are stresses in resin trapped between fibers that are tensile and that result from a differential shrinkage of the resin compared to the glass rather than stresses that might be set up as a result of polymerization.

2. These tensile stresses are of the order of several thousand pounds per square inch at room temperature.

3. These stresses are due solely to the existence of a bond between the glass and the resin.

It should be pointed out that the stress measurements were conducted on specimens that are far larger than actually occur in laminates. But if the stress is due solely to the differential shrinkage between the glass and the resin, then so long as there is a sound band be-

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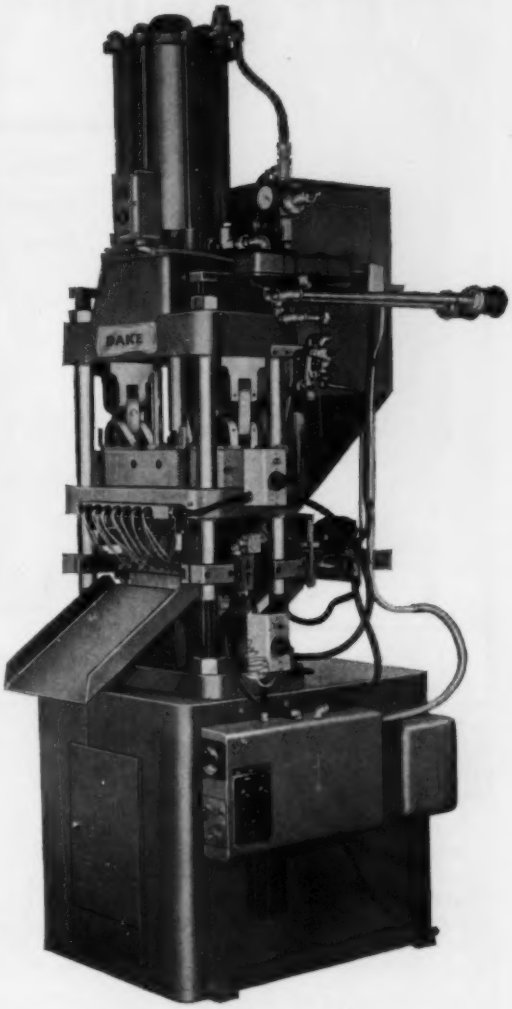

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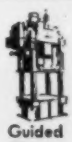
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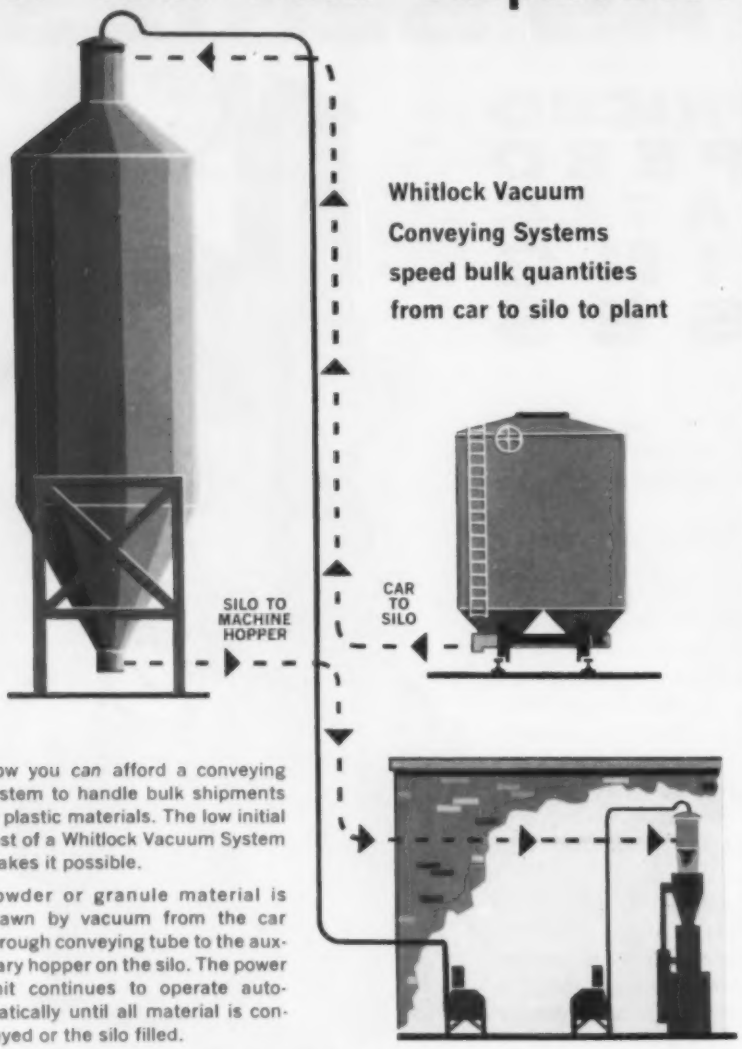

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tween the glass and the resin, this stress should be independent of the size of the model. Thus, we can see that there are large tensile forces tending to break the bond between the glass and the resin within reinforced plastics. If this bond is allowed to be broken, then passages will open up throughout the bundles of fiber which will conduct fluids into the interior of the laminate.

Figure 1 shows the existence of these channels and gives strong evidence that any striation that might be visible within a laminate may be due to the existence of small channels through the fiber, each of which is capable of conducting a liquid. It is easy to see that if this is the case then the bonds between the resin and the glass are continually trying to open and destroy the internal integrity of the laminate. The resistance to this tendency to separation appears due solely to the adhesive bond that exists between the resin and the glass. The several factors that tend to upset this adhesive bond will lead to the permanent deterioration of the laminate.

We can also see from Figs. 8 and 9 that the stresses between the glass and the resin are drastically increated by a post-curing treatment, therefore, one might tentatively propose that a post-cure treatment would be disadvantageous to the durability of a laminate.

Further work is being done to determine the absolute magnitude of the stresses within a laminate and methods of reducing them are being devised.

The research forming the basis of this article was conducted in the laboratories at the University of Vermont under the sponsorship of the National Science Foundation and the Office of Naval Research. The authors are greatly indebted to the valued discussion with H. A. Perry of the U.S. Naval Ordnance Laboratory in Washington, D. C.

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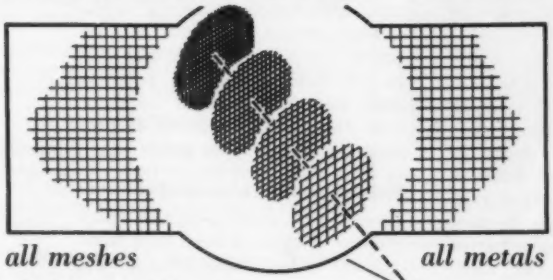

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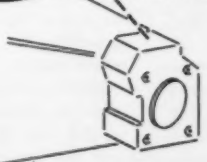

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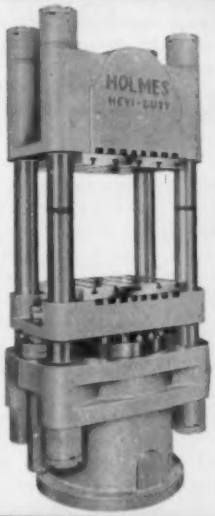

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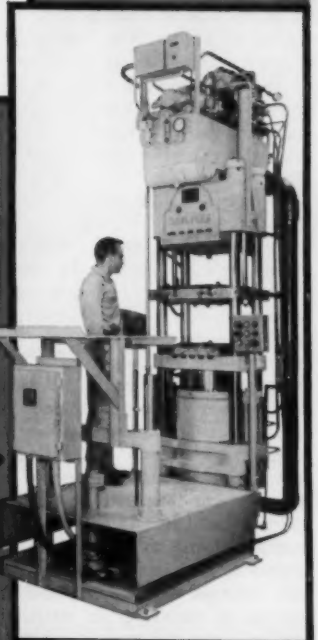

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You're invited to send for descriptive material plus facts and figures. No obligation, of course.

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THE PLASTISCOPE*

Important news . . . and what it means

By R. L. Van Boskirk

Section 2 *(Section 1 starts on p. 41)*

September 1961

Monomer cast nylon to open new markets

A process for casting massive, complex shapes directly from nylon monomer without pressure is expected to open new markets for nylon in heavy industrial parts, particularly those now cast in metals. Such parts are used in metalworking, steel making, railroad transport, paper converting, materials handling, mining, construction, and many other fields.

The material, trademarked MC nylon, is a product of The Polymer Corp., Reading, Pa., which has acquired from Monsanto Chemical Co., developers of the process, exclusive rights to produce nylon shapes by monomer casting.

Castings from MC nylon cost between $3 and $5/lb., a range said to be substantially lower on a per-piece basis than that of stainless steel, brass, or bronze castings, and competitive with alloy steel castings. And Polymer Corp. expects developments in the field to bring unit costs down to about 50% of the present level, bringing monomer cast nylon to a competitive level with carbon steel and aluminum castings.

The process has tremendous economic advantages over injection molding of nylon polymer. By converting nylon raw materials directly into finished items, five steps required in normal conversion are eliminated, thus raw materials costs are about 50% lower. Moreover, since the liquid monomer polymerizes to a uniform solid without forming vacuum bubbles, parts of unlimited thickness can be cast. Mold costs for casting the new nylon into large pieces are said to be far less than with conventional injection molding and extrusion. It is emphasized, however, that the new process is not intended to compete with injection molding for mass production of small nylon parts; the economic edge for monomer is found only in large-part production.

MC nylon is described as a nylon 6 formulation, but it is further stated that the material has physical properties equal to and often better than other nylons, and the properties can be economically tailored for specific end-use requirements.

The material is commercially available in stock shapes, such as tubular bars, up to 4 ft. in length, and in plate up to 4 in. thick in 4- by 4-ft. sections. Larger shapes are also now in limited production.

*Reg. U.S. Pat. Off.

Electrically conductive molding compound

A new static-electricity draining, fibrous glass-reinforced polyester molding compound, designated Grade X-1011-F, has been developed by The Glastic Corp., Cleveland, Ohio. Parts produced with the new material are said to exhibit good physical strength and corrosion resistance, in addition to complete static draining. Applications include blowers for explosion-proof equipment, components for equipment used in operating rooms, paper conversion plants, textile mills, chemical plants, mines, and printing plants.

Black in color, the compound is priced from 63¢ to 69¢/lb., depending on quantity.

Acrylate monomers with low inhibitor level

Methyl acrylate and ethyl acrylate monomers, which have an inhibitor concentration of only 15 parts per million, have been announced by Rohm & Haas. Heretofore, these monomers have been supplied with a much higher inhibitor content (200 ppm. or more) to provide stability during shipping and storage.

Dr. E. H. Riddle, in charge of acrylic monomer sales for Rohm & Haas, states that "these acrylate monomers, inhibited with only 15 parts per million of monomethyl ether of hydroquinone, maintain their stability under extreme storage conditions. They withstand heating to 130° F. for at least 30 days without evidence of polymer formation, thus meeting a stability test suggested by I.C.C. for monomers." Actually, it has been found that the monomers remain fully stable for a period of many months when held at this elevated temperature, Dr. Riddle says.

Polymer manufacturers frequently have had to distill the monomer to remove the inhibitor. Such distillation may no longer be required, offering a significant savings in processing costs. In some applications, polymer manufacturers have found it unnecessary to remove the inhibitor even when present at high concentrations. Under such conditions the use of methyl acrylate or ethyl acrylate with only 15 parts per million of inhibitor offers several advantages. It may result in shorter polymerization time (because of much shorter induction period), more complete conversion of monomer to polymer, and less tendency for color development —sometimes attributable to the presence of inhibitor.

Industrial products in which these monomers may be used include plastics, leather finishes, saturating and coating compounds for textiles, paper coatings and saturants, paints, and floor finishes.

Single component epoxies

A series of single component epoxy molding compounds, claimed to cure in as little as 15 sec., has been developed by the Adhesive, Resin & Chemical Div. of the American-Marietta Co., Seattle, Wash. A dry granular material, the new EMC 90 series, developed for component encapsulation and structural uses, is said to be non-burning, and has a storage life of one year or longer at room temperatures. Available in blue or black, mineral-filled EMC 90 compounds are said to permit high flow at low temperatures and pressures, while providing excellent mold release and complete rigidity of parts upon ejection from the mold.

Semiconductive polyethylenes

Three new quasi-conductive polyethylene compounds have been developed by Union Carbide Plastics Co. for use as inner layers and/or outer jacketing on communications and power cables.

Most conductive of the three (less than 1½ ohm-cm. volume resistivity) is Bakelite DFDA-0520. Designed only for internal use in cables, it is recommended as voltage stress relief shielding in high-voltage cables. It also can replace copper braid as an electrical interference barrier.

For external cable jacketing, DFDC-5275 (resistivity less than 10 ohm-cm.) is recommended as lightning protection on multiconductor

News about R&A SINCE 1913 **Adhesives**

FOR ALL METALS AND ALL PLASTICS

These soft-seam vinyl foam bonds withstand coating-solvent attack

8 typical Bondmaster® adhesives for flexible foams:

FOR CLOSED-CELL VINYL FOAMS

BONDMASTER G483-20: Widely specified for athletic protective equipment, gymnasium mats, etc; withstands standard vinyl protective coatings.

BONDMASTER R379-20: Highest strength, salt water, humidity and solvent resistance; withstands hot vinyl marine coating dips.

FOR POLYURETHANE & RUBBER LATEX FOAMS

BONDMASTER R275: Outstanding economy coupled with softest, dimple-free seams. For urethane and rubber latex foams to themselves or to each other.

BONDMASTER R322: R275 type in a non-flammable solvent. Soft seam, quick-grab, dries tack-free.

BONDMASTER R828: Highest strength bonds of polyurethane and vinyl foams to wood, metal, or other rigid surfaces, and to many fabrics.

BONDMASTER R203: Extremely fast drying for instantaneous bonding of fabric reinforcing tapes to polyurethane or latex foam cushions, etc.

FOR POLYETHYLENE FOAMS

BONDMASTER G590: High strength "contact" type adhesive for **foamed** polyethylene to itself, to wood, metal, hardboard, etc. Good heat-resistance; excellent resistance to salt water and high humidity conditions.

BONDMASTER G523: "Longer-open-time" variation of BONDMASTER G590.

WRITE FOR DETAILED TECHNICAL DATA

R&A SINCE 1913

RUBBER & ASBESTOS CORPORATION

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The water-ski-belt-in-the-making, shown above, not only demands a solvent-resistant, high-strength foam-to-foam bond, but also the firmest possible anchoring of the nylon-coated fabric ties to the closed-cell vinyl foam slabs.

Other flotation equipment and most athletic protective gear (helmets, knee pads, etc.) also require sturdy bonds between the foam and phenolic or other plastics (both rigid and flexible), or metal, wood, composition board, etc.

While BONDMASTER G483 is shown being brushed, it can also be roll coated or sprayed with conventional equipment to provide a tough, high-peel-strength bond (featuring a *soft seam*) which has superior resistance to:

a) solvent attack by most vinyl marine coatings;

b) salt water and high humidity;

c) fatigue and vibration;

d) oil, grease and gasoline;

e) prolonged exposure to temperatures up to 180°F.

Surfaces coated with this formulation feature "quick grab" and produce bonds of foam-tearing strength instantly upon contact, thereby making BONDMASTER G483 particularly applicable for mass production assembly operations.

WRITE FOR FREE DATA

Write for 3-page "Technical Data Sheet on BONDMASTER G 483" detailing application techniques, spray instructions, adhesive laydown, etc., for the bonding of closed-cell vinyl foams.

THE PLASTISCOPE

(From page 254)

cables such as underground communications cables for missile sites. Properties claimed for this new PE include excellent stress-cracking resistance, low-temperature impact strength, flexibility, and good elongation characteristics over a wide temperature range.

The third new polyethylene, DHDA-7800, is recommended for external jacketing where a moderate degree of conductivity is required. With volume resistivity less than 50 ohm-cm., it is said to have excellent stress-cracking resistance and elongation, good impact strength, and low-temperature properties.

Both DFDA-0520 and DFDC-5275 cost 65¢/lb. in truckload quantities; DHDA-7800 is priced at 50¢/lb.

Almost-water-white polycarbonate resin

A new grade of polycarbonate resin designed for lenses, light covers, diffusers, and other applications requiring clarity has been announced by the Chemical Materials Dept., General Electric Co., Pittsfield, Mass.

Designated Lexan 102, the new nearly water-clear polycarbonate is said to have the same physical, electrical, and chemical properties as previous grades offered in the company's polycarbonate resin line. Its improved clarity results from use of additives masking the natural light-amber color of the resin and preventing darkening during molding. Price is $1.30/lb. in truckload lots, the same as standard grades.

Orlon-reinforced phenolic

New Orlon fiber-reinforced phenolic molding compound developed by Rogers Corp., Rogers, Conn., is said to have mechanical stability with good insulating and electrical properties, chemical resistance, and toughness. The material, RX 745, is supplied in modular form for automatic preforming and molding equipment, and reportedly molds well in thin sections.

Bronze-plastic repair compound

A new repair compound, consisting of 80% bronze and 20% epoxy is now available from Devcon Corp., Danvers, Mass. The compound is said to have been successfully field-tested by foundries for filling large blow holes and other imperfections in bronze and brass castings. A pump manufacturer reportedly saved $600 and three week's shipping delay by using Devcon BR to repair four large castings which had been machined incorrectly. A paper mill extended the life of three large pumps and valves by building up the inside dimensions of these units. A ship builder on the East Coast used it to repair large marine propellers.

New polyester resin

A polyester resin, said to be so flexible that a casting made from it will not crack or shatter when a nail is driven through it, has been announced by Archer-Daniels-Midland Co., Minneapolis, Minn. Called Aropol Q-6030, the resin is recommended for auto body repair compounds, calking and sealing compounds, gaskets, and laminations where flexibility and toughness are desired. Impact strength, vibration dampening, and low exotherm suggest its use for potting and encapsulation of electronic components. It is also suitable for marine and outdoor applications because of excellent water resistance, the company states.

Rigid urethane potting compound

A new potting material made with rigid urethane foam that protects the parts embedded in it against shock, vibration, corrosion, and dampness is available from Freeman Chemical Corp., Port Washington, Wis. The nonfriable foam has a density of approximately 10 to 12 lb./cu. foot. Other properties of the foam potting material include a K factor of 0.25, tensile strength of 405 p.s.i., flexural strength of 128 p.s.i., compressive strength at yield point of 375 p.s.i., and a 6% deflection at yield.

A different urea

A new chemical-grade urea, introduced by Sohio Chemical Co., Lima, Ohio, is being distributed under the tradename of Solar Urea. The new urea is made by a new manufacturing technique—the Vulcan-Inventa Urea process—and a Stora-Vulcan evaporator installed at the Solar Nitrogen Chemicals Inc. plant at Lima. Sohio Chemical operates the Lima plant and also acts as sales agent for Solar. The Vulcan process, according to Sohio, gives Solar Urea the easy-to-handle advantages of the free-flowing prilled form.

Asbestos-base RP

Two new reinforced plastics made with asbestos and proprietary phenolic resins have been introduced by the Advanced Materials Div. of Taylor Fibre Co., Norristown, Pa. The new materials, designated Tayloron PA and PA-6, were developed specifically for use in rocket components and other high-temperature applications.

Tayloron PA is said to have excellent thermal insulation, heat resistance, good ablation performance, high tensile and flexural strength, and good impact resistance.

Tayloron PA-6, made with highly purified asbestos is said to have similar thermal and mechanical properties but reportedly has better ablation properties and greater strength in continued service at temperatures as high as 500 to 700° F. It has been used in components of solid-fuel rocket engines in considerable quantities, the company claims.

Epoxy-metal compound

Development of an epoxy-metal compound specially designed to fill, bond, and repair steel, iron, aluminum, bronze, brass, concrete, marble, porcelain, wood, glass, leather, and most hard plastics has been announced by the Consumer Products Dept. of The Borden Chemical Co.

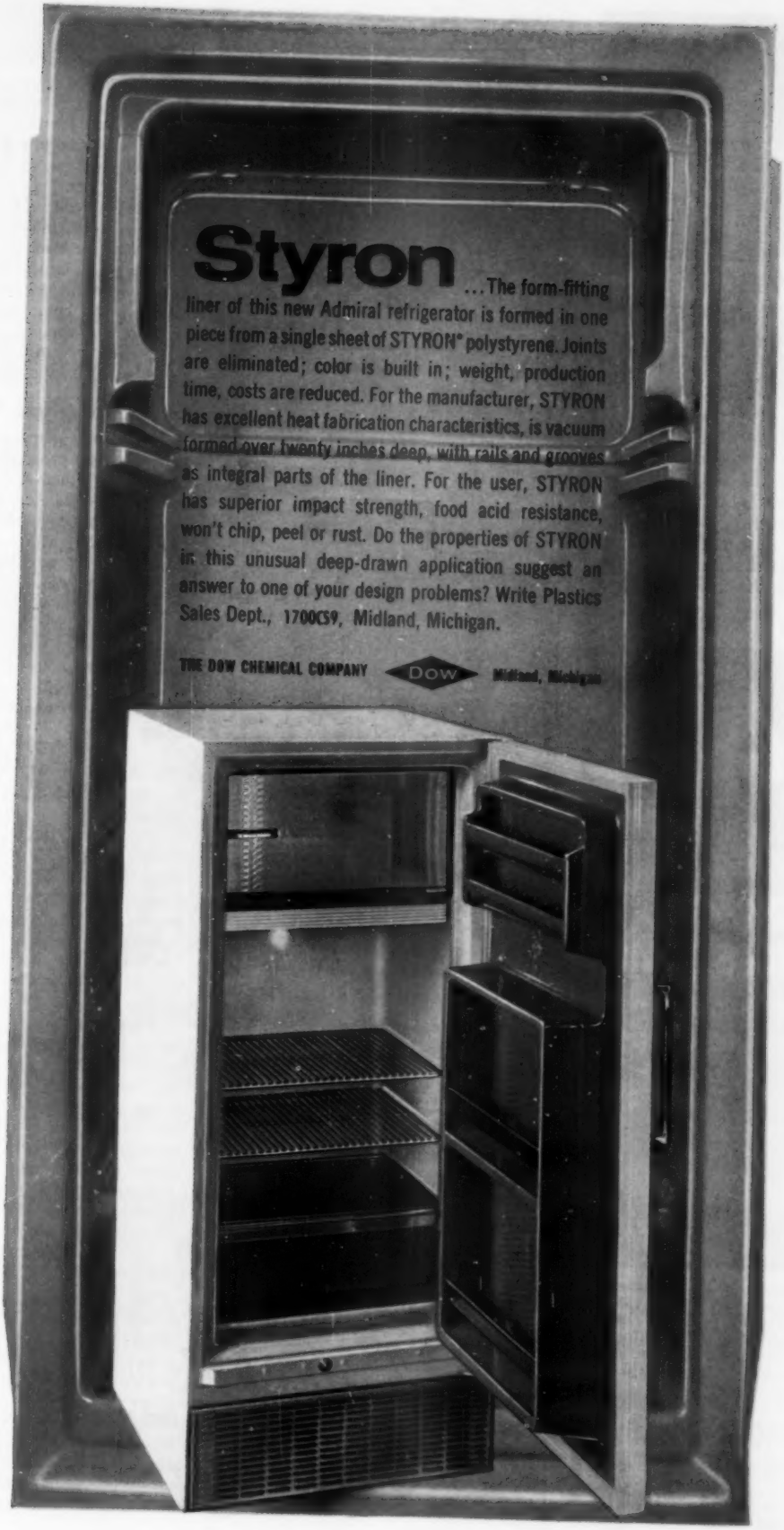
Called Elmer's All-Purpose Epoxy Metal Compound, the new product is a two-part system consisting of a can of metal-filled epoxy resin and a can of hardener which mixes to double the amount of the unit size. The product sets in 2 to 4 hr. at room temperature and cures overnight. Shelf life is rated by the company as "indefinite." Available in ½-pt. to 1-gal. units, suggested retail prices for the new product are from $5.50 for ½-pt. size units to $60 for gallons.

Dustless flame retarder

A new, non-dusting material for incorporation in chlorine-containing plastic films and coatings has been introduced by Metal & Thermit Corp., Rahway, N. J. The new antimony oxide formulation, called Thermoguard (ND), is said to be readily dispersible in plastic formulations and to provide good flame retardation.

Low-cost plasticizer

A resinous plasticizer for vinyl chloride polymers and copolymers, has been announced by R. E. Carroll Inc., Trenton, N. J. Designated Recco 159, the new material is a mixture of resinous and non-volatile aromatic esters from which all light and fugitive materials have reportedly been removed. The plasticizer is said to be completely insoluble in aliphatic hydrocarbons and water, compatible with Buna N and the various vinyl chloride polymers and copolymers. It is said to be highly grease- and oil-resistant and is recommended by the manu-


Styron ...The form-fitting liner of this new Admiral refrigerator is formed in one piece from a single sheet of STYRON® polystyrene. Joints are eliminated; color is built in; weight, production time, costs are reduced. For the manufacturer, STYRON has excellent heat fabrication characteristics, is vacuum formed over twenty inches deep, with rails and grooves as integral parts of the liner. For the user, STYRON has superior impact strength, food acid resistance, won't chip, peel or rust. Do the properties of STYRON in this unusual deep-drawn application suggest an answer to one of your design problems? Write Plastics Sales Dept., 1700CS9, Midland, Michigan.
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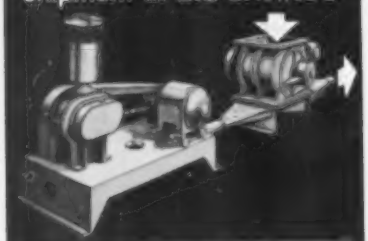

Write for Bulletin 228 showing standardized components, capacities, horsepower requirements — complete information on how to order without delay or outside assistance.

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Size Reduction • Size Classification • Mixing & Blending
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THE PLASTISCOPE

(From page 256)

facturer for gasoline- and solvent-resistant hose, gaskets, belting, and various mechanical goods. Recco 159 is available in drum quantities at 14½¢/lb. f.o.b. Trenton, N. J.

Adhesive for service at 400° F.

A new two-component, room-temperature-curing adhesive, said to maintain its strength at temperatures up to 400° F. has been announced by The Epoxylite Corp., South El Monte, Calif. Designated #810, the adhesive consists of an epoxy paste and a powdered hardener. Although bake-cure epoxy adhesives are available for 400° F. service, the company claims it has not been chemically possible before this time to achieve adequate cure in epoxy resins at room temperature to withstand the thermal softening effects of 400° F. temperatures. Most room temperature cure epoxy adhesives soften at 165 to 200° F., according to the firm.

Improved catalyst

Because of new manufacturing processes, U. S. Peroxygen Corp., Richmond, Calif., claims it has increased resistance to metallic contamination and at the same time eliminated the possibility of water-phase separation of its Hi Point 180 MEK Peroxide, room-temperature catalyst for vinyl, acrylic, and polyester type resins. According to the company, the resistance to metallic contamination in no way impairs the catalyst's reactivity with common metallic promoters such as cobalt, naphthenate, and a number of similar materials.

Polymer emulsions

Acid-soluble and acid-dispersible copolymer emulsions called NeoCryl A-410 and A-400, respectively, have been announced by Polyvinyl Chemicals Inc., Peabody, Mass. Both emulsions are not affected by water, soap, or alkaline detergents, the company claims, yet can be quickly and easily removed with mild acidic cleaners. The new emulsions contain functionally active groups that can interact with carboxyls, acid chlorides, acid anhydrides, etc., such as may be present in fibers, coatings, and films. Applications suggested by the company include photographic chemicals; coatings for paper, adhesives, textiles, and leathers; and floor and shoe polishes.

Conductive ink

Conductive ink for plastics has been announced by Advance Process Supply Co. Inc., Chicago, Ill. The company states that after application of the ink, designated Thermo-Plastic Formulation No. EL-796, the plastic can be processed any way necessary to make products requiring low-current electrification. Products of this type include battery-operated toys, other electrical toys, games, etc. Adhesion is said to be excellent on polystyrene, and acrylic; adhesion qualities on butyrate are said to be good.

The inks are black and their resistance per sq. in. screened through 8XX mesh is approximately 400 ohms. This resistance can be varied by the user as desired. A sprayed, roller coated, or screened protective coating can be used, the company states.

Coating for foamed products

A new finish developed specifically for foamed plastic products has been announced by Flood & Conklin, Newark, N. J. Called Acry-Dyl, the coating is reported to be suitable for use and compatible with polystyrene and other foamed plastic materials. It requires no primer, sprays on with standard equipment, and dries quickly, the company states. The new finish is said to improve scuff resistance and ability to withstand temperature fluctuations in such products as ice buckets, picnic hampers, and refrigerator panels.

Acrylic modifier for PVC

A new processing aid for polyvinyl chloride, Acryloid K-120N, has been announced by Rohm & Haas Co., Philadelphia, Pa. This is an improved grade of Acryloid K-120 which was introduced five years ago, and is characterized by more uniform particle size.

On the mill, the modifier is said to promote a smooth bank and faster mixing. In calendering, reported advantages are faster machine speeds, better surface qualities, better roll release, freedom from roll plating, and improved gloss. In extrusion, better surface qualities and increased heat stability are claimed. In most operations lower processing temperatures are permitted.

According to Rohm & Haas, K-120N is completely compatible with all grades of unplasticized vinyl.

Antioxidant for polypropylene

A new non-staining phenolic antioxidant has been announced in pilot plant production by Imperial Chemical Industries Ltd., Millbank, London, England. Developed especially for polypropylene by I.C.I. Heavy Organic Chemicals Div., Topanol CA in combination with dilauryl thiodipropionate is said to give good protection during the processing stages of polypropylene, and subsequently imparts stability

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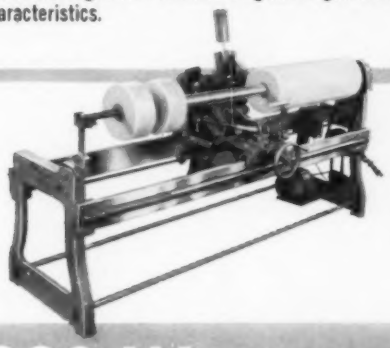
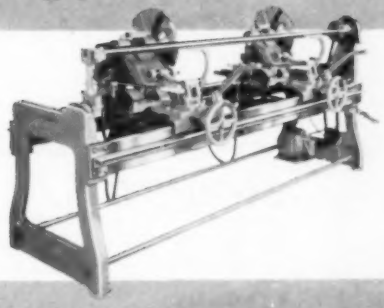
You must see these revolutionary new machines to fully realize their total efficiency and profit producing features. Now, no experience is necessary to trim or cut rolls in a fraction of the time needed on an ordinary slitter rewinder. Without consideration to web tensions, variable rewinds, soft spots, gauge variations and edge registration, you can trim off as little as 1/16" on any roll up to 14" diameter for a finished roll absolutely flat at the edges without disturbing the original rewind characteristics.



360-V4 Single Knife Roll Cutter. This rugged heavy duty unit is specifically designed for trimming off roll edges and cutting to various widths. It rough cuts and trim cuts roll to exact width. Edges are perfectly smooth and flat. No fusing or flagging.



380-V4 Twin Head Single Knife Roll Cutter. This special unit is identical to the 360-V4 except that independently operating double cutting heads are provided. Ideally suited for edge trimming without turning roll or moving cutting head.

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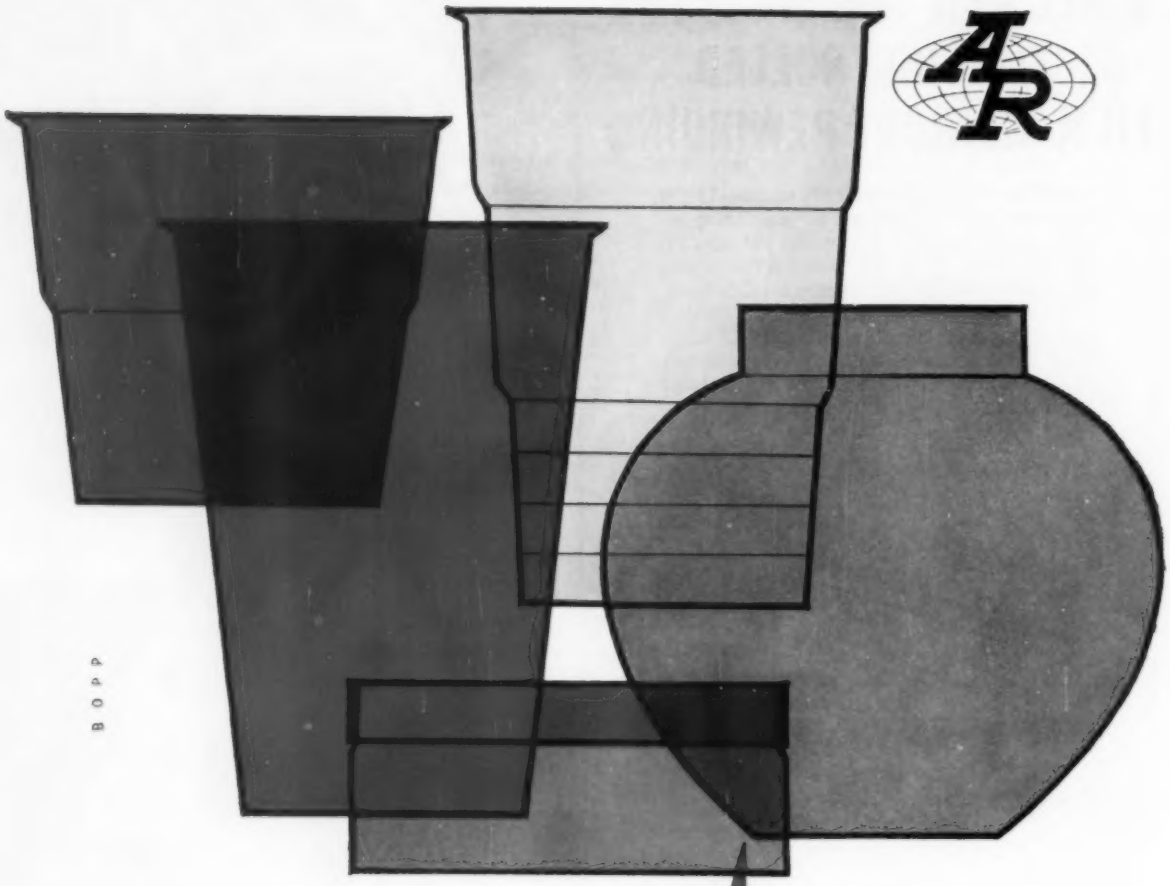

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(*From page 258*)

during fabrication and use over a long period, especially in the presence of copper, *e.g.* in electrical applications. Topanol CA alone is also claimed to be a superior antioxidant in polyethylene and might be of interest in other polymers, such as polyesters.

Paint for polyolefins

A new coating, P-38, designed for use on flame-treated or chemically-oxidized polyethylene or polypropylene has been introduced by Bee Chemical Co., Lansing, Ill. The new paint, available in a wide range of colors and metallics, is said to be a fast touch-dry spray coating with good mar resistance and excellent flexibility.

Dry-cleanable adhesives for urethanes

A series of one-package adhesives for the wet laminating of fabrics to polyurethane foam or to other fabrics has been developed by Custom Chemicals Co. Inc., East Rutherford, N. J. According to the company, the new adhesives are resistant to washing and dry cleaning solvents (including perchloroethylene and trichloroethylene). Polyether as well as polyester type urethane foams may be used. Being one-package systems, the adhesives are said to have unlimited package stability and do not require addition of catalysts or other additives. They may be applied by roller coating, spray, or rotogravure, and do not require any heat for curing, the company states.

Epoxy coating

An epoxy coating that is said to prevent granular and abrasive materials from sticking to bins, hoppers, and storage and materials handling equipment has been introduced by Frederic B. Stevens Inc., Detroit, Mich. Called Epoxy Resiweld, the material imparts a hard glass-like covering on practically any surface. According to the company, tests under severe conditions are said to have shown that the new coating resists wear and reduces sticking by nearly 100 percent. The material can be brushed, rolled, or sprayed and requires a minimum of drying time. One gallon will coat 400 to 500 sq. ft. of area, according to the company.

Flexible gel coat

With the development of a new basic polyester resin formulation, Commercial Resins Corp., St. Paul, Minn., claims a new flexible, quick-curing, easy-handling gel coat that has good gloss and hiding characteristics. Ac-

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Lauroyl Peroxide	95.0%	(Min.)
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Material	Solvent	Temp. °C.	Half Life in Hours
ALPEROX C	Benzene	100	0.1
Benzoyl Peroxide	Benzene	100	0.33
ALPEROX C	Benzene	70	3
Benzoyl Peroxide	Benzene	70	12

ALPEROX C (Technical Lauroyl Peroxide) is the preferred catalyst for the suspension polymerization of vinyl chloride. Concentrations of 0.1 to 1.0% confer greater heat stability on the final product and facilitate higher conversion velocity. As a catalyst for curing polyester resins, it is especially applicable to the production of small, clear, transparent castings, setting at a temperature of 60° to 80°C. For cold setting with tertiary amines as accelerators, less discoloration occurs than when using benzoyl peroxide.

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Photograph courtesy of Conolite Division, Continental Can Company.

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THE PLASTISCOPE

(*From page 261*)

cording to the company, a film of cured Co-Rezyn flexible Gel Cote cast on a piece of glass can be removed and rolled up like a piece of rubber. This same flexible film, as the gel coat on a fibrous glass laminate, has excellent scuff and mar resistance. It is said to withstand 24 hr. in boiling water. The coating is available transparent or it can be colored by addition of 2.5% by weight of any polyester color pastes.

Urethane odor masks

Development of three types of masking agents for urethane foam has been announced by Noville Essential Oil Co., North Bergen, N. J. Two of the masking agents are said to give the scent of freshly laundered linen to such products as foam pillows, mattresses, fabrics laminated with urethane, etc. The third is intended for neutralizing amine mal-odors. All withstand high processing temperatures, the company claims.

To produce polypropylene film

Commercial availability of extruded unoriented polypropylene film has recently been announced by Elm Coated Fabrics Co., New York, N. Y., a manufacturer of calendered vinyl film.

The PP film is available in gages from ¾ mil to 8 mils and in widths up to 54 inches.

Initially, three grades are being offered: film without slip additive for overwrap and lamination, film with slip additive for bag stock for food packaging applications, and specially formulated film for wire and cable wrap applications.

Enlarged polystyrene and polyolefin lines

A new series of polystyrene impact materials and two new polystyrene crystal resins have been announced by Rexall Chemical Co.

The company is now offering a range of impact polystyrene graft copolymers custom tailored to specific application requirements which runs in Izod impact strength from 0.375 to 3.5 ft.-lb./in. of notch. These materials are being manufactured at Rexall's Holyoke, Mass. and Santa Ana, Calif. plants.

The two new polystyrene crystal products are Elrex 110R, a heat resistant polystyrene (190 to 195° F.), which is said to exhibit superior flow as well as good elongation and tensile strength; and Elrex 220E, an easy-flow polystyrene claimed to offer low

How SANTICIZER® 409 gives vinyl products high-priced properties at the lowest cost of any premium polymeric plasticizer

PERFORMANCE: SANTICIZER 409 *stays put.* Its compatibility-stability is superior, under highly humid conditions, particularly when formulated with heat-stabilizing epoxy plasticizers. SANTICIZER 409 stubbornly resists migration to polystyrene—and to both natural and synthetic rubbers—as well as extraction by solvents. Stability to light and heat is exceptional. There's hardly a trace of odor or color.

PROCESSING: The good solvating action of SANTICIZER 409 can boost your output, too. Promotes fast fusion and extrusion. Helps prevent "fisheyes," roughness, and pinholes.

PRICE: SANTICIZER 409—*at 4¢ to 6¢ per lb. LESS than other premium-quality polymerics*—imparts top-quality performance to many kinds of vinyl products.

PROOF: Try it . . . "on paper," in the laboratory, in the plant. Compare SANTICIZER 409 with *any* other polymeric plasticizer (price, properties, stability, ease of processing). You will see that SANTICIZER 409 gives *more profit per unit volume of vinyl compound.*

FACTS: Technical Bulletin PL-409 gives complete performance data—including specific details on how SANTICIZER 409 can help you make:

- **105° wire compound with exceptional electrical properties and retention of elongation.**
- **permanent, adhesive-backed film.**
- **migration-resistant, low-odor refrigerator gasketing.**

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MONSANTO CHEMICAL COMPANY
Organic Chemicals Division
Plasticizer Council, Dept. 4410-C
St. Louis 66, Missouri

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RUGGED·QUALITY

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ALSTEELE ENGINEERING WORKS—FRAMINGHAM, MASS.

THE PLASTISCOPE

(*From page 263*)

"molded-in" strain and an excellent balance between flow and physical properties.

Rexall also made it known recently that it is marketing a complete line of polypropylene resins on a resale basis but has not revealed the source of their material. The present arrangement is similar to Rexall's resale arrangements on conventional high-pressure-produced polyethylenes and linear low-pressure-produced PE.

Polypropylene will be available at Rexall warehouses in Holyoke, Mass., Chicago, Ill., and Santa Ana, Calif.

Rexall and El Paso Natural Gas Products Co. announced in April 1960 their joint venture for the production and marketing of polyethylenes and polypropylenes. They are currently building a 180 million lb./yr. plant for the production of ethylene and propylene at Odessa, Texas. They also are building a 120 million lb./yr. plant for low-density polyethylenes to be completed in the first quarter of 1962. No announcements regarding the timing of their polypropylene plant or high-density polyethylene plant have been made to date.

Rector forms new company

Clinton Rector has established a new company in Washington, D. C. to produce plastics sealing and insulating compounds for the electronics industry, heavy industry, and maritime industries. "Pete," as he has been known in the industry ever since his early days in the 1920's when he first worked for Bakelite, was formerly Chief of the Plastics Section in the War Production Board. For the past 15 years he has been with National Engineering Products of Washington. Miss M. A. Hunt, who was Mr. Rector's assistant at National, has joined him in the new operation. Location of the plant is at 318 Randolph Place, N. E., Washington 2, D. C.

Fabrics for airhouses

A new line of vinyl coated fabrics specially developed for fabrication of inflatable air houses has been introduced by Vulcan Div. of Reeves Bros., Inc., New York., N. Y. Marketed as Coverlight-V, the material is available trimmed in a width of 56 in. and in weights of 12, 16, 18, and 20 oz., and in a variety of colors.

Competition in laminates

A new, low-cost decorative laminate for furniture, counter tops, cabinets, walls, and doors has been announced by Titan Chemical Corp., Los An-

How MOD-EPOX® liquefies viscous epoxy resins and "liquidates" some of the cost

PERFORMANCE: Reactive MOD-EPOX reduces epoxy resin viscosity as much as 75%, combines *chemically* in the curing to become part of the resin. This means you can use more filler, yet have faster flow, less entrapped air, fewer rejected finished parts. And final properties are actually *improved:*

FLEXURAL STRENGTH OF 4-PLY GLASS FIBER-EPOXY LAMINATES (ASTM D638)

FORMULATION:	Control	with MOD-EPOX
MOD-EPOX	—	25
liquid epoxy resin	100	100
diethylenetriamine	12	8
magnesium oxide (fluffy)	—	0.25
FLEXURAL STRENGTH:	psi	psi
original	42,400	48,400
ketone—40 hrs. @ room temp.	42,400	47,700
water—40 hrs. @ 100°C.	29,400	37,600
10% caustic—27 hrs. @ 100°C.	8,500	9,200

Epoxy resins modified with MOD-EPOX for better flow and lower cost show better dimensional stability—lower power factor—equivalent hardness—and higher adhesive strength (*shear bond strength of a standard epoxy adhesive increases more than 50%, steel-to-steel*).

ECONOMY: NOW . . . MOD-EPOX at 36¢/lb.* costs less than any grade or brand of epoxy resin, 50-75% less than most other modifiers . . . AND reduces the curing-agent requirements to about ⅔ of usual amounts.

FACTS: Technical Bulletin PL-313 gives complete performance data—including specific details on how MOD-EPOX can help you make:

- **easy-handling electronic potting compounds.**
- **low-cost auto-body-solder formulations.**
- **high-strength casting and encapsulating compounds.**
- **tenacious adhesives for metals and glass.**

*T/L and C/L, F. O. B. Monsanto, Illinois

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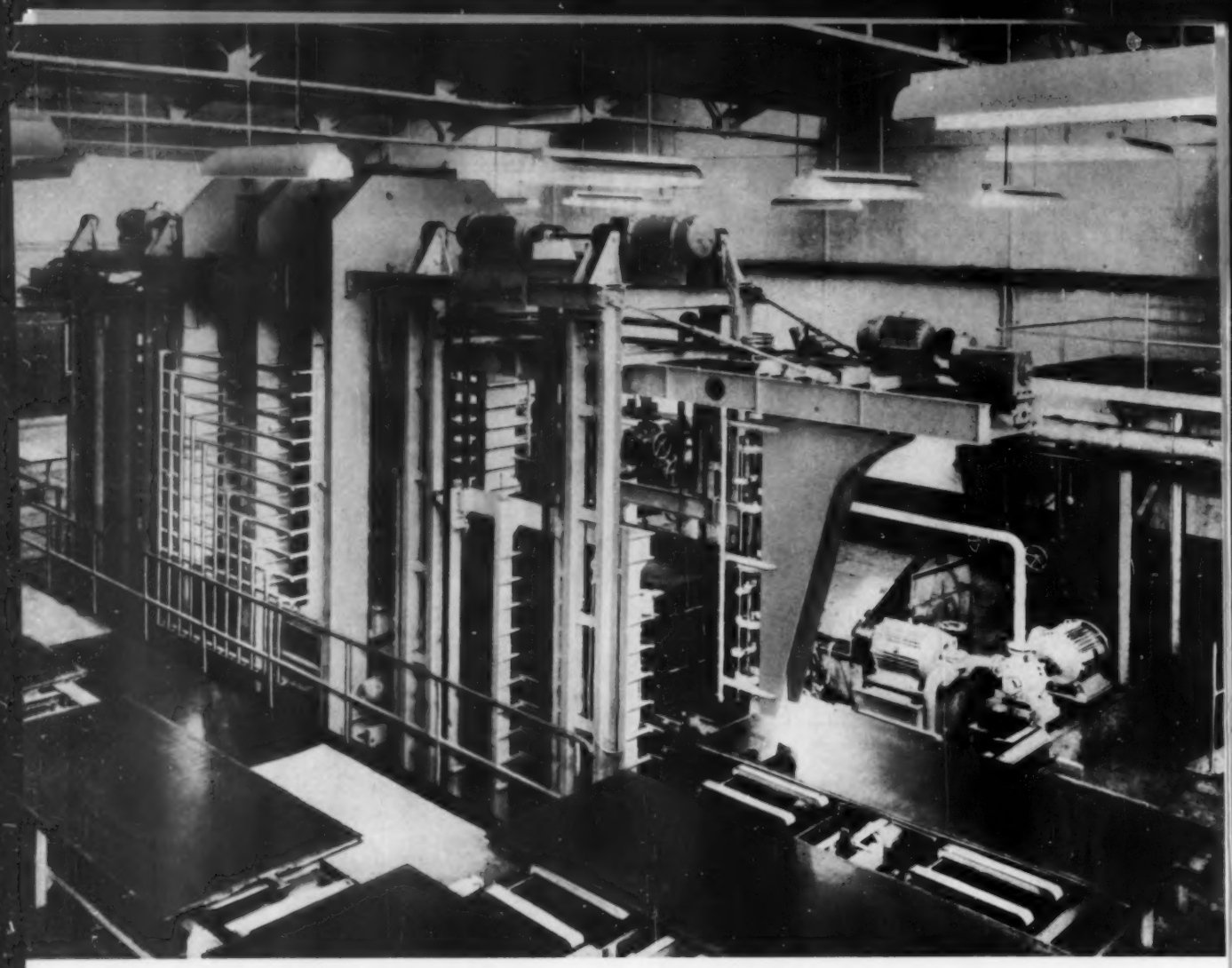

Press installations for decorative plastic laminates

- Laminated boards
- Laminating fibre boards
- Laminating chip boards

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THE PLASTISCOPE

(*From page 265*)

geles, Calif. Tradenamed Titanite, and based on a concept developed by FMC Corp., the laminates are prebonded to hardboard, particle board, plywood, and other core materials, and manufactured under electronically controlled heat and pressure. No glue or other bonding agents are employed, the company states.

Titanite is manufactured in sheet sizes up to 48 by 96 in., and 30 by 120 in., and in thicknesses from 12 mils through 2 inches. Titanite decorative laminate board is also available in specific length, width, and thickness dimensions (cut to size) as required, thereby reducing waste and labor costs.

Shrinkable film package

Use of Reynolon, an oriented PVC shrinkable film for multi-packing of refrigerated biscuits has been announced by Gladiola Biscuit Co., Dallas, Texas. This is claimed to be the first instance of such biscuits being packaged in shrinkable PVC.

The multiple packing of six biscuit canisters in a heat-shrunk film overwrap offers several important advantages to grocery store operators and consumers, according to B. T. Erwin, vice-president and general manager of Gladiola. The new multipack will be a boon to grocery store managers and clerks, he said, because it will simplify handling and price marking of refrigerated biscuit inventories. Instead of 24 individual biscuit canisters to every case, there will now be just four six-packs to handle.

Machine used in the heat-shrink overwrapping operation is Packaging Machinery Company's U-6 model.

Transparent PVC tubing

A transparent polyvinyl chloride tubing claimed to combat corrosion in the transmission of gases, acids, alkalies, petroleum products, sea water, etc., is available from Newage Industries Inc., Jenkintown, Pa. Called Clearflo, the tubing is non-porous and said to have almost mirror-like interior and exterior surfaces which resist staining, bacterial growth, and dirt accumulation. For use with high pressures and to resist crushing, Clearflo is also avaliable in two reinforced versions. One is reinforced with a steel wire spring and the other features a nylon braiding having burst pressures up to 1000 p.s.i.

The new tubing is also available in a food grade formulation, Clearflo F.G., which the company claims can handle delicately flavored substances

How SANTICIZER® 160 speeds processing and cuts costs of nonstaining PVC film and sheeting

PERFORMANCE: No other plasticizer can make film, sheeting, and floor covering so *STAIN-SAFE*—virtually impervious to asphalt, tar, grease, mustard, catsup, coffee, and other stainmakers. SANTICIZER 160 (butyl benzyl phthalate) also imparts toughness, high gloss, *and outstanding tear strength and dimensional stability.*

PROCESSING: Quick-fusing SANTICIZER 160 speeds Banbury mixing, milling, and calendering—*at lower processing temperatures.*

ECONOMY: SANTICIZER 160 is one of the lowest-priced primary plasticizers for vinyls. With its high tolerance for fillers and its high compatibility—*150 PHR for poly(vinyl chloride), 75 PHR for poly(vinyl acetate)*—it offers compounders savings on material, savings on formulation.

"TAILORED" BLENDS: In large-volume applications, when several plasticizers are used together in a fixed ratio for optimum performance, Monsanto can usually *custom blend* them to your specifications . . . to reduce your storage-facility requirements; eliminate mixing error or variation; and reduce inventory requirements, ordering costs, and production expense.

FACTS: Technical Bulletin PL-160 gives complete performance data—including specific details on how SANTICIZER 160 *also* can help you make:

- **lower-cure-temperature plastisols and organosols.**
- **high-gloss, water-resistant lacquers.**
- **economical vinyl chloride-vinyl acetate emulsions.**

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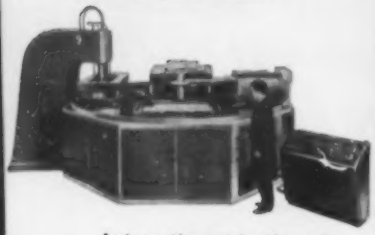
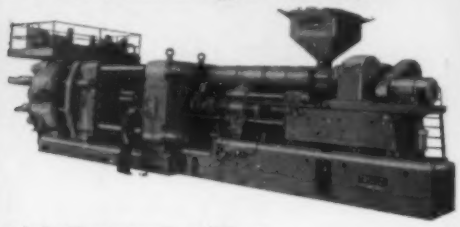
ROTOR-BLOW-MATIC



Automatic production of 120 doorliners per hour sheared and drilled.

Mod. 12/350/2200 the biggest in the world!



- injection capacity: 423 oz
- plasticizing capacity: 770 lbs/h
- locking force: 2420 U.S. tons
- dry cycles up to: 120/h

Preplastmatic

- **OIL OPERATED** Vickers hydraulics
- **AUTOMATIC** Siemens electrics.

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BRNO Fair—
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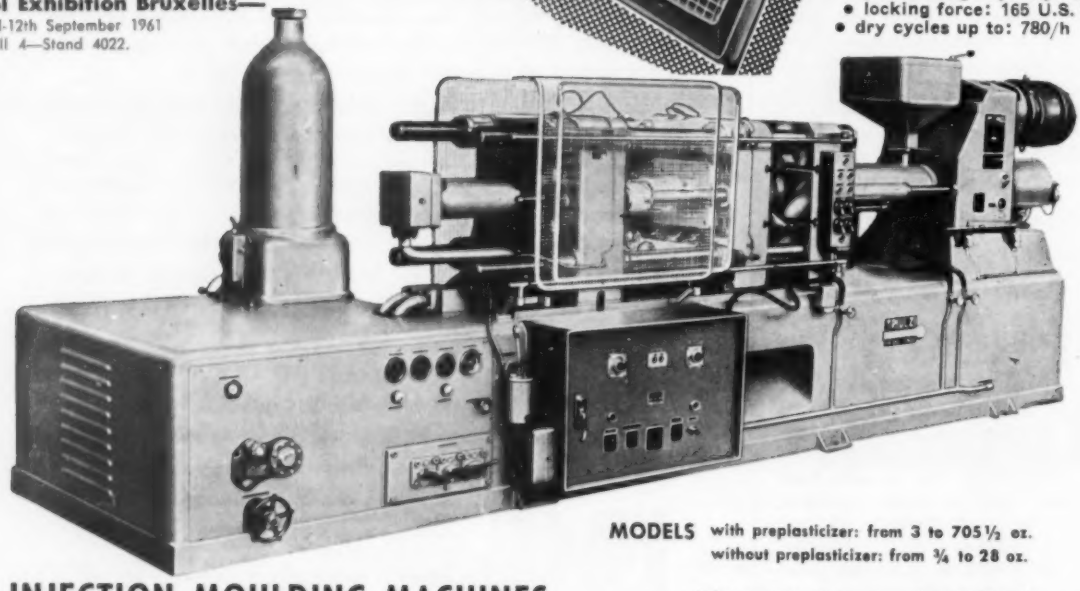
7th European Machine Tool Exhibition Bruxelles—
3rd-12th September 1961
Hall 4—Stand 4022.

MOD. PREPLASTMATIC 300/40/150

- injection capacity: 10 3/5 oz.
- plasticizing capacity: 88 lbs/h
- locking force: 165 U.S. tons
- dry cycles up to: 780/h



MODELS with preplasticizer: from 3 to 705½ oz.
without preplasticizer: from ¾ to 28 oz.

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Other presses of our normal production line:

- Vertical presses for thermosetting resins.
- Blow-moulding machines for hollow items in plastics.
- Screw and extruding plants for plastics for the production of films, rigid and flexible sections, cable covering, plastics colouration and granulation.
- Presses for polyesters, for plastics laminates
- Record moulding presses.
- Special plants for plastics processing.

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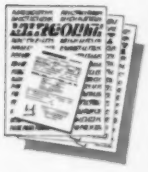

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THE PLASTISCOPE

(*From page 267*)

with perfect safety. It is said to be ideal for bottling machines.

New companies

Harrison Development Co., 20818 Harper Ave., Detroit, Mich., has recently been formed to specialize in the urethane field. It produces polyurethane coatings and adhesives under the tradename Ureflex.

Valtek Plastics Inc., 554 Eben St., New Haven, Ind., has been organized as a custom injection molder and extruder. **Roger E. Valentine** is president; **Wayne I. Pribble,** v-p in charge of engineering; and **John L. Haugsrud,** v-p in charge of production.

Henolite Products Inc., 100 Bridge St., Phoenixville, Pa., a newly formed corporation for molding of foam styrene products will begin operations this fall. **Henry C. Lavely,** president, and **Norman J. Huber,** vice-president, were formerly with Koppers Co. Inc., Pittsburgh, Pa.

Trophy Industries Inc., 5738 Long Beach Ave. East, Los Angeles, Calif., has been formed by **Louis Urbach,** president, to fabricate vinyl sheet and film products such as swimming pool liners, air mattresses, inflatable toys and other types of heat-sealed products. The company will do both custom and proprietary work.

Fipro Inc., 1150 Southard St., Trenton, N. J., has been formed by **Walter A. Steene** for the manufacture of reinforced plastics products. The company offers custom pattern and mold making facilities for items manufactured from fibrous glass and polyester or epoxy resins.

Expansion

Celanese Plastics Co. will expand blow-molded container production in the Midwest and on the East Coast. The firm is constructing a blow-molded container plant on a 17-acre site in Batavia, Ill., where it currently produces polyethylene film. When the new building is completed in October of this year, production of blow-molded containers will be transferred from the present 25,000-sq.-ft. Chicago plant to the new container facilities, which offer 90,000 sq. ft. of manufacturing area.

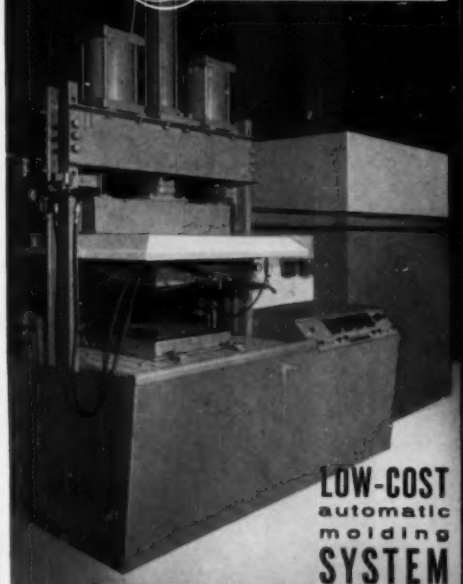
The company has also purchased a plant building in New Castle, Del., and is expected to transfer blow-molded container production there

EXPANDABLE POLYSTYRENE

NEWS:

A low-cost, automatic molding system to produce high-quality expandable polystyrene products is now available. This system is compact. It saves floor space. Yet, it combines all the equipment needed for high production molding. Included is a 50-ton vertical press, hot-air pre-expander, compact steam generator, vacuum pump, and central control console. And, because Expandex Corp. is also experienced in custom molding, the EX-2 System has been thoroughly tested in use.

EXPANDEX



LOW-COST automatic molding SYSTEM

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☐ Please send folder on Custom Molding.
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Company.....
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- Encapsulation
- Vacuum Metallizing
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- Liquid Resin Metering, Mixing, Dispensing
- Vacuum Casting
- Vacuum Heat Treating
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UP-TO-DATE SYSTEMS — BOTH STANDARD & CUSTOM

HULL CORPORATION
Hatboro, Pennsylvania

Export Division: 1505 Race St., Philadelphia 2, Penna.

THE PLASTISCOPE

(*From page 269*)

from Trenton shortly. Situated on a 14-acre site, the New Castle facility will provide more than twice the manufacturing area presently available at the Trenton installation.

National Starch and Chemical Corp. has announced plans to build a $4 million, 45 million lb./yr. vinyl acetate monomer plant at an undisclosed site in Texas. Construction is scheduled to commence late this year, and the new facility is expected to be in complete operation during the fall of 1962.

Mobay Chemical Co. plans to construct additional plant facilities for the manufacture of a broad range of organic isocyanates adjacent to its tolylene diisocyanate plant at New Martinsville, W. Va. The new addition, which is expected to have a production capacity of several hundred tons per month, is scheduled for completion for early 1962.

Plax Corp., Hartford, Conn. producer of blow-molded containers, is erecting a one-story manufacturing building of approximately 146,000 sq. ft. in Yardville, N. J. Plans call for the building to be ready for occupancy in the fall of this year, and company spokesmen foresee an initial employment of approximately 200 persons at the new facility.

Brown Machine Co., Beaverton, Mich. manufacturer of vacuum forming machines and component equipment for the plastics industry, is constructing an 18,000-sq.-ft. building which will more than double present manufacturing capacity. The new building is scheduled for completion in October.

Spraylat Corp. has tripled its manufacturing facilities to 18,000 sq. ft. in a move to larger quarters at 730 S. Columbus Ave., Mt. Vernon, N. Y. The company has been a specialist for 25 years in the production of spray-on strippable vinyl and acrylic protective coatings.

Hysol Corp., Olean, N. Y., has purchased the Epoxy Electrical Insulation Potting and Encapsulation product line of **Permacel Div.** of **Johnson & Johnson.** Hysol will manufacture and market these materials and will service the former Permacel's customers for the epoxy potting and encapsulating line only. Both companies will continue to produce and

market their other traditional product lines.

Shell Chemical Co. has completed expansion of its styrene monomer production facilities at Torrance, Calif., which raises the plant's capacity to 210 million lb./yr. from a rated capacity of 125 million lb./yr. in 1955. Completion of the new program results in a total expansion of nearly 70% since the plant has been in private operation.

Raw materials for styrene are benzene and propane, which are produced in large quantities in Southern California by Shell and other refiners that supply the Torrance plant.

Synthane Corp., Oaks, Pa., has installed 34 pieces of specialized machinery at Synthane-Pacific, the firm's new West Coast branch in Glendale, Calif. Synthane produces copper-clad laminated plastics for printed circuits for aircraft and electronics firms.

Voi-Shan Industries Inc. has acquired the business, assets, and name of **D-M-E- Corp.,** formerly **Detroit Mold Engineering Co.,** manufacturer of mold bases and related mold components. **I. T. Quarnstrom,** founder and president of D-M-E, will manage the subsidiary. D-M-E operates manufacturing plants in Detroit, Mich., and Hillside, N. J., and a steel processing plant in Youngwood, Pa.

Pratt, Read & Co. Inc., Ivoryton, Conn. manufacturer of piano and organ components and small tools, has acquired the **Tech-Art Plastics Co.,** Morristown, N. J., custom molder of plastics materials. Tech-Art will continue its present operations at the Morristown plant, retaining its identity as a wholly-owned subsidiary of Pratt, Read. Its former board chairman, **J. Harry Du Bois,** becomes vice-president of the newly acquired firm. Tech-Art's plant in Morristown was built in 1951 and contains molding machines for both thermosetting and thermoplastic materials.

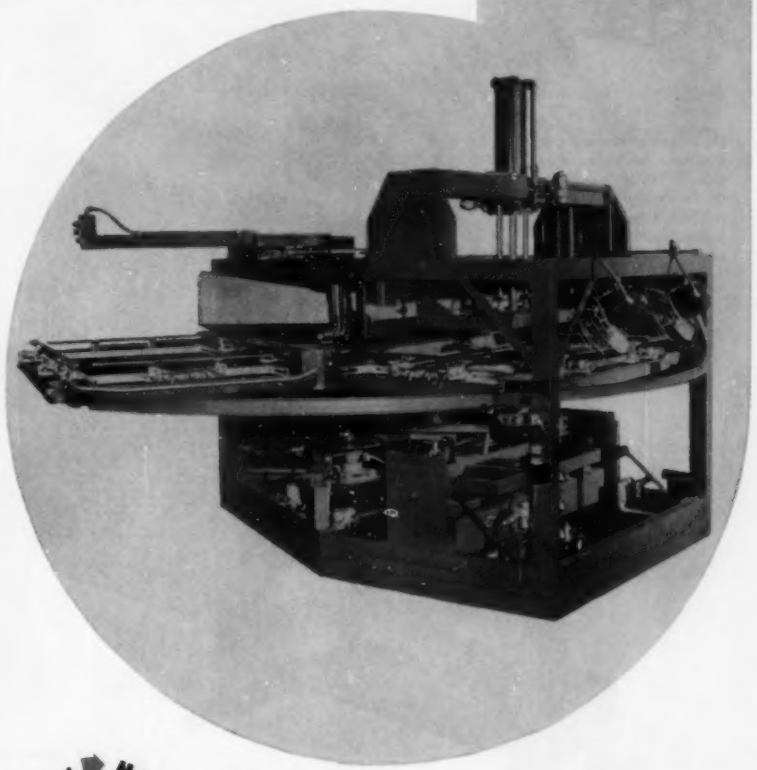
Barron Plastics Inc., Woodlawn, Ohio, custom fabricator of molded plastic signs and letters, has expanded its operation to include the making of plastic sign faces for sign manufacturers who have no fabricating plants of their own. **Leo H. Lackner,** former president of Plastisign Suppliers Inc., Cincinnati, Ohio, has joined Barron as general supt.

Northwest Plastics Inc., St. Paul, Minn. molding firm, has purchased **Hermitage Plastics,** Nashville, Tenn. producer of miniature electrolytic condenser enclosures. **(To page 274)**

VERSATILITY-HIGH PRODUCTION

BROWN 223 Rotary Forming Machine

The Brown 223 is a three station unit that combines extreme forming versatility with high production. Basically, the 223 consists of three clamp frames rotating in a horizontal plane through three loading, heating and cooling stations. In normal operation the 223 will form sheet thicknesses to .500 by any technique known. For example, the 223 will form .100" thick impact polystyrene sheet at rates up to 120 cycles per hour. Standard machines can make parts to 24" depth of draw.



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EXTRUDERS, COMPLETE PRODUCTION PACKAGE UNITS, ACCESSORIES...

Polishing roll stands with NRM-built mirror-finish rolls.

New monofilament production package. Features NRM-designed Godet stands with unique roll drive features, melt pump, quench and annealing equipment.

Complete line of sheet, film, pipe and wire coating dies.

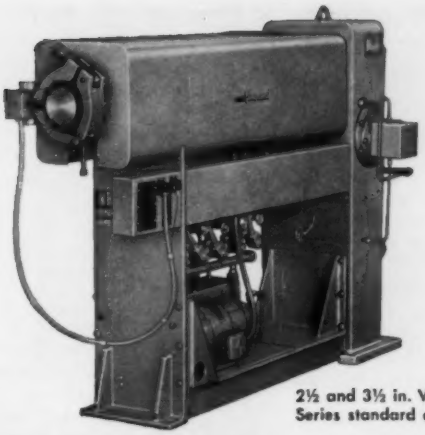
1 and 1½ in. laboratory extruders.

As the only manufacturer of standard thermoplastic extruders, in sizes from 1 through 15 in., NRM can recommend extrusion equipment *exactly* matched to your present and future needs.

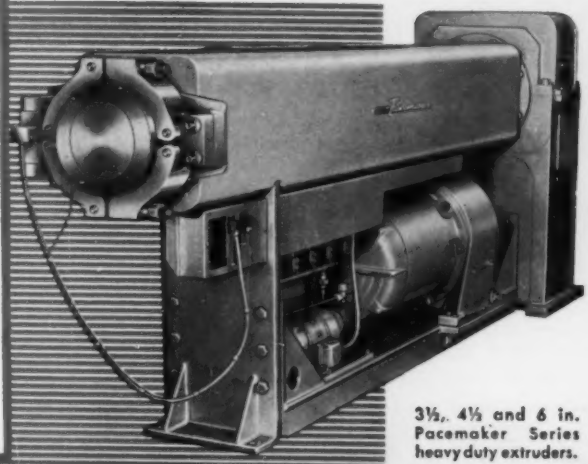
In fact, NRM builds complete package units for production of flat or corrugated sheet, plastic pipe, flat or blown film, monofilament, pellets, and for wire coating.

Extruder-dryers . . . custom extruders for special applications . . . dies . . . haul-offs . . . tanks . . . vacuum hoppers . . . related accessories — NRM offers them all.

And, NRM'S years of experience in the development and manufacture of the finest plastics production machinery available today are at your service. Whether you're concerned with productivity, product quality, cost reduction, or a new process, you'll be money ahead if you call in NRM for recommendations while your project is in the planning stage. Call, wire or write today.



2½ and 3½ in. Vanguard Series standard extruders.



3½, 4½ and 6 in. Pacemaker Series heavy duty extruders.

2223-A

8, 10, 12, and 15 in. high-capacity extruders.

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THE PLASTISCOPE

(*From page 271*)

Hermitage is also a manufacturer of seamless tubing by the spin molding process, and a custom formulator of epoxy compounds. Sale price was in excess of $100,000.

White Sewing Machine Corp. has acquired **Fibreglass Ohio Inc.** and will combine its production capabilities with those of White's **Apex Reinforced Fibre-Glass Div.,** a producer of filament-wound pressure bottles and centrifugally-molded tanks, containers, and materials handling units for military, automotive, and industrial uses.

Barnett J. Danson & Associates Ltd. has announced establishment of a pilot customer service and demonstration lab at its warehouse at 16 Newbridge Rd., Toronto, Canada. The company, which has recently been appointed U. S. and Canadian distributor of powder mixers produced by Vaterland-Werk, Neuenrade, W. Germany, will demonstrate these units at the new facility. Applications include high speed mixing and heating of powders and granules for dry blending of rigid and flexible PVC materials, color dispersion, drying, and densifying. Other equipment such as Alsteele granulators, Farris Universal take-offs, and Mokon mold temperature control units are already in the lab and will be supplemented by Whitlock conveyors shortly.

Lothar Bohlmann has joined the company as technical service manager, and **Stuart H. Jacobs** has been appointed secretary-treasurer.

Imperial Chemical Industries Ltd. and **Emser Werke A. G./Inventa A. G.** of Switzerland have announced an agreement whereby I. C. I. has acquired rights and patents relating to Emser Werke/Inventa's new processes for manufacture of nylon-6 polymer and caprolactam, on which nylon-6 is based. At the same time, I. C. I. has announced plans to construct a 15,000 ton/yr. caprolactam plant at I. C. I.'s Severnside site and a large-scale plant for manufacture of nylon-6 polymer. Production is scheduled for early in 1963.

Nopco Chemical Co. announced acquisition of title to a 90,000-sq.-ft. building and 18.75 acres of land from **Brown Rubber Co. Inc.,** Lafayette, Ind. Nopco plans to install and operate urethane foam production facilities at the new location to cover the Midwest market.

Deceased

R. K. Turner, 59, a vice-president of **Union Carbide Corp.,** died suddenly on July 18, at his home in Larchmont, N. Y. He had been with Union Carbide Corp. since 1924, when he joined **Union Carbide Chemicals Co.** at Clendenin, W. Va. He moved to the **U.C. Plastics Co.** in 1952 as a vice-president, and was appointed president of that division in 1957. He was elected a vice-president of Union Carbide shortly before his untimely death.

R. K. Turner

William Lloyd Cone, 69, died after a heart attack at his home in Dallas, Texas, on July 18. He was president of **Plastics Manufacturing Co.** in Dallas. He had been general manager of the dinnerware molding firm since 1942. Later he was elected vice-president, and became president in March of this year. He was chairman of the **Melamine Division** of the **Society of**

W. L. Cone

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Synthetic

PEARL PIGMENTS

for **COMPOUNDING INTO**

- POLYETHYLENE
- POLYSTYRENE
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- NITRATE
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- PHENOLICS (CAST)
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RONA PEARL PIGMENTS are heat and light stable, non-reactive, non-corrosive, and impart high pearly luster, exceptional depth and brilliance at very low cost.

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. . . See at a glance the properties of many natural and synthetic pearl pigments, their chemical and physical characteristics, and recommended uses.

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2

MATERIALS AND PROCESS

Openings for

PLASTICS ENGINEERS

The Transport Division of The Boeing Company has a number of outstanding openings for plastics engineering specialists with a degree in one of the physical sciences and practical experience in plastics usage, evaluation, development or design. Salaries range from $7,000 to $12,000.

Areas of assignment include developmental and evaluation programs to determine choice and use of plastics materials in aircraft components and to provide process requirements to meet aircraft standards. Involved also is consultation with other engineering groups, manufacturing personnel and suppliers. Materials covered include reinforced plastics, all thermoplastics, synthetic fibers, foams and casting resins.

Send your resume, today, to Mr. Ivan G. Phillips, The Boeing Company, P. O. Box 707-81L, Renton, Washington. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

BOEING

...why take risks on uneven catalyst activity?

Today, the most uniform economical urethane foams are being made with a new catalyst produced by M&T, the pioneer in the development of "one-shot" catalysts. This is CATALYST T-9,* specially manufactured to give a predictably high activity that is retained through normal storage and use. Because of its proved performance, M&T CATALYST T-9 has replaced stannous octoate in most "one-shot" systems, establishing new standards for fast and dependable reaction catalysis and foam uniformity.

Obtain more information about CATALYST T-9 by writing or calling Metal & Thermit Corporation, the only company that produces a complete line of tin catalysts.

*Pat. Applied For

M&T "ONE-SHOT" CATALYSTS INCLUDE:

M&T CATALYST T-9 (stannous type)
Stannous Octoate and Stabilized Stannous Octoate
M&T CATALYST T-12 (organotin type)
M&T CATALYST T-8 (dibutyltin di-2-ethylhexoate)

OTHER M&T PRODUCTS FOR PLASTICS:

THERMOLITE® Organotin Vinyl Stabilizers
THERMOLITE® Ba-Cd and Auxiliary Stabilizers
THERMOGUARD® H- High Tinctorial Strength Antimony Flame Retarder
THERMOGUARD® L- Low Tinctorial Strength Antimony Flame Retarder

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M&T Chemicals

METAL & THERMIT Corporation, Rahway, N. J.

Sn Sb P | inorganics and
Si Ti Zr | organometallics

In Canada: M&T Products of Canada Ltd., Rexdale, Ontario

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- National distribution of secondary stock offerings
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- To carry "future" inventory through commodity transactions . . .

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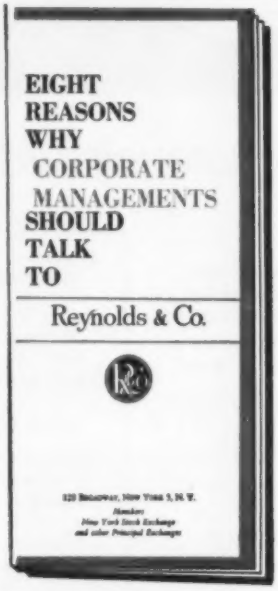
The various areas in which we can help executives are summarized in a new brochure entitled "Eight Reasons Why Corporate Managements Should Talk To Reynolds & Co." For your copy, just clip this coupon to your corporate letterhead.



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THE PLASTISCOPE

(From page 274)

the Plastics Industry. Mr. Cone was one of the pioneers in the melamine dinnerware industry.

Coming events

Plastics groups

Oct. 5: S.P.E. Buffalo Section, Retec, "Plastics Foams," Hotel Lafayette, Buffalo, N. Y.

Oct. 12, 13: S.P.I. 17th Annual New England Section Conference, Wentworth-by-the-Sea, Portsmouth, N. H.

Oct. 17-19: The Plastics Show of Canada, Canadian National Exposition, Toronto. Contact: W. B. Pryde, Show Manager, 481 University Ave., Toronto, Canada.

Nov. 1-3: S.P.E. 1st Southwestern Packaging Exhibition in conjunction with North Texas Section, S.P.E., Retec on "Plastics in Packaging," Sheraton-Dallas Hotel, Dallas, Texas.

Nov. 15: S.P.E. New York Section with cooperation of Vinyl Plastics PAG, Retec, "Vinyl Plastics in the Household," Statler-Hilton Hotel, New York, N. Y.

Dec. 1: S.P.E. Cleveland Section, Retec, "Plastics Screw Injection Molding," Cleveland Engineering Society Building, Cleveland, Ohio.

Dec. 9: S.P.I.-S.P.E. Midwest Sections, Annual Christmas Party, Grand Ball Room, Pick-Congress, Chicago, Ill.

Jan. 30-Feb. 2, 1962: S.P.E. 18th Antec "Plastics Revolutionize Design," Penn-Sheraton Hotel, Pittsburgh, Pa.

Feb. 6-8: S.P.I. 17th Reinforced Plastics Div. Conference, Edgewater Beach Hotel, Chicago, Ill.

Other groups

Oct. 9-11: Technical Assn. of the Pulp & Paper Industry (TAPPI), 16th Plastics-Paper Conference, French Lick-Sheraton, French Lick, Ind.

Oct. 18-20: Packaging Institute, 23rd Annual National Packaging Forum, Biltmore Hotel, New York, N. Y.

Oct. 26, 27: 3rd Annual Symposium on High-Speed Testing, sponsored by Plas-Tech Equipment Corp., Natick, Mass., Hotel Somerset, Boston, Mass.

Nov. 27-Dec. 1: 28th Exposition of Chemical Industries, Coliseum, New York, N. Y.

Dec. 5-7: Building Research Institute, Fall Conferences, Shoreham Hotel, Washington, D. C.—**End**

Tableware by Bopp-Decker Plastics, Inc., Birmingham, Mich.

It's Escon® polypropylene!

When a shopper picks up a product made of Escon polypropylene, a good part of the selling is already done. Escon has a rich, warm, solid feeling which says "quality" better than words.

Smart merchandisers are capitalizing on this quality feel in housewares, packaging, closures and containers to add extra appeal to their products. It's one form of sales insurance which costs very little—but makes a big difference in results.

Escon has many appealing properties which help put a product over at the point of sale. For full details, write to Enjay, 15 W. 51st St., N.Y. 19, N.Y.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

ENJAY

now you can foam vinyls better, faster, at less cost with Du Pont Nitrosan® blowing agent

FOAMED VINYL COMES OF AGE

HERE'S HOW: You can now produce foamed vinyls with gratifyingly low capital investment – and surprising ease.

Du Pont "Nitrosan" is the key. It gives you a combination of properties not available in any other chemical blowing agent.

It releases nitrogen at relatively low temperatures – significant gas release starting at 190°F.–thus foaming the vinyl *before* it reaches gelation temperature. This enables you to obtain a finer cell structure, uniform thickness, and densities as low as 5 or 6 pounds per cubic foot.

And, it means you can manufacture vinyl foam without a large capital expenditure.

Example: foamed vinyl sheeting or vinyl synthetic leather. For example, if you now make vinyl sheeting or coat fabrics, or paper, you may be able to swing right into production of *foamed* vinyl sheeting or vinyl synthetic leather with *no additional investment in equipment.* Even if you are *not* now making PVC sheet, the equipment you will require to make vinyl foam from "Nitrosan" will be less expensive than for other routes. You work with an easy-to-handle plastisol, instead of a composition that must be calendered.

How "Nitrosan" works. "Nitrosan" is a free-flowing powder which is incorporated in your plastisol like any other ingredient. When subjected to temperatures above 190°F., it releases nitrogen and generates a cellular structure. To vary the amount of foaming you simply vary the concentration of "Nitrosan."

The exothermic heat of decomposition of "Nitrosan" is a mild 450 calories per gram. When you make thick, molded vinyl objects, this low exotherm keeps the temperature at the center of the slab low enough to prevent degradation of the vinyl – a serious problem with other, more exothermic blowing agents.

Makes better, lighter, easier-to-emboss foams. Because it foams the vinyl *before* gelation, "Nitrosan" gives these new and distinctive advantages:

Densities can be as low as 5 or 6 pounds per cubic foot – opening up possibilities for new products you couldn't consider in the past.

Cell structure can be either open or closed type. Most commonly, "Nitrosan" is used to produce the open type, because the resultant interconnected fine cells give a more luxurious hand to the product.

Sharper embossing patterns can be made, as a result of the lower density and the fine open-cell structure of vinyl foamed with "Nitrosan."

Properties and handling characteristics of "Nitrosan". "Nitrosan" contains approximately 70% by weight N,N'-dimethyl-N,N'-dinitrosoterephthalamide and 30% inert material.

It has good thermal stability at normal ambient temperatures.

Heating at 175°-190°F. produces sustained and rapid decomposition of "Nitrosan." About 125 ml. of nitrogen is evolved per gram of blowing agent. Extensive technical data and "know-how" on vinyls foamed with "Nitrosan" are available to you.

Simply write or wire Chemical Products Sales Div., Explosives Dept., 6539 Nemours Bldg., Wilmington 98, Del., or contact any of these district sales offices:

BOSTON: 140 FEDERAL ST., HA 6-1724/CHARLOTTE: 427 W. FOURTH ST., FR 5-5561/CHICAGO: 7250 N. CICERO AVE., LINCOLNWOOD, OR 5-1010 (FROM CHICAGO, IN 3-7250)/CLEVELAND: 11900 SHAKER BLVD., LO 1-5070/HOUSTON: P.O. BOX 22207, MO 7-9197/LOS ANGELES: 2930 EAST 44TH ST., LU 2-6464/NEW YORK: 4700 EMPIRE STATE BLDG., LO 3-6400

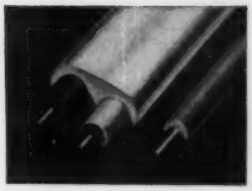
where **NITROSAN**® *saves money, ups quality:*

VINYL SYNTHETIC LEATHERS
can now be made in low investment equipment. Uniform gauge, sharper embossing and the luxurious hand of open-cell foam are some of the advantages of using "Nitrosan."

FOAMED VINYL SHEETING
made with "Nitrosan" is breathable. Densities as low as 5 and 6 lb./cu. ft. open up new uses, such as embossed quilted insulation.

MOLDED VINYL FOAM
for cushions, gaskets, and other applications not only costs less to make, but thermal degradation of the resin due to the blowing agent is eliminated since "Nitrosan" functions with only a mild evolution of heat. Faster operating cycles are thus possible with assured high quality of product.

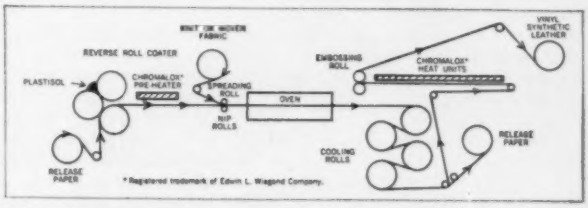
WIRE INSULATION
can be extruded at nearly twice the speed permitted by blowing agents that decompose above the gelation temperature of the vinyl. Further, foaming reduces resin requirements by 50%, and produces light weight insulation while improving electrical properties.



FLOTATION EQUIPMENT
can be molded under pressure, producing a closed-cell structure with all the usual advantages of "Nitrosan": low foaming temperatures, low exotherm, easy handling, fast operation and low equipment costs.

typical process:

Here's how "Nitrosan" is used to make foamed vinyl sheeting and synthetic leathers, continuously on equipment requiring only modest investment.



1. Spread plastisol containing "Nitrosan" over skin which has already been applied to commercially available release paper.
2. *Apply mild heat* to prevent strike-through, if adding an open fabric backing.
3. Apply fabric or other backing such as paper or plastic sheeting.
4. Pass entire laminate through oven. Typically, the oven consists of two zones: the first at 250°F., (80 seconds residence time, for foaming) the second at 350°F., (40 seconds residence time for fusing).
5. Fully foamed and fused laminate emerges from oven, passes over cooling rollers.
6. Peel off and roll up release paper. Because you foam with moderate temperatures, you can re-use the release paper several times.
7. Pass foamed vinyl laminate over embossing roller for leather-like graining or other texture.
8. Collect finished product on roll.

This is just one example of the varied products and process schemes possible when you use "Nitrosan." Besides supported or unsupported sheeting, you can make thick slabs, extrusions, wire coatings, molded products–all with the processing and quality advantages inherent in the use of "Nitrosan."

DU PONT NITROSAN® *blowing agent*

REG. U.S. PAT. OFF.

Better Things for Better Living . . . *through Chemistry*

COMPANIES...PEOPLE

Firms and personnel in the news—what they're doing . . . and where

Monsanto Chemical Co.—Plastics Div., Springfield, Mass.: **John R. Kent** and **Stanley R. Melvin** appointed tech. service specialists. **Donald R. Mahaney** named asst. product sales mgr., polyolefins; **Robert R. Morner** appointed tech. service rep., Opalon resins and compounds; **Edward H. Myers** named asst. tech. service mgr., styrene polymers; **Alfred J. Roche** has been appointed asst. product sales mgr., Lustrex.

Union Carbide Plastics Co.: Frank G. Bertics appointed Midwestern regional sales mgr., with offices in Chicago, Ill. **James N. Barton** named tech. sales rep., Western sales region, with headquarters in Los Angeles, Calif.

Union Carbide Chemicals Co.: Howard L. Harwell named product mgr.—flexible foams, and **Dr. Richard J. Kerr,** appointed product mgr. epoxies and plasticizers, in the New Chemicals Group. **John K. Harvey** named product mgr.—propylene oxide and amines for the Industrial Chemicals Group.

Wyandotte Chemicals Corp.: Carl Smith elected v-p industrial chemicals marketing. **Clinton J. Allen Jr.** appointed admin. asst. to pres., **Robert B. Semple.**

Tube Turns Plastics Inc., Louisville, Ky.: **Milo H. Buzzee** promoted to engineering mgr., and **David W. Baird III** to tech. dept. mgr.

General Electric—Laminated Products Dept., Coshocton, Ohio: **Douglas J. Clark** appointed industrial sales rep. He will cover Mich. and Western Ohio, with headquarters in Detroit.

Swedlow Inc. has consolidated its Youngstown, Ohio military and defense sales by product lines, under a national sales headquarters in Los Angeles, Calif., and appointed the following: **Charles M. Phinny,** mgr., reinforced plastics sales; **Kenneth G. Granger,** mgr., transparent plastics sales; and **Walter A. Williams,** sales mgr. high temperature coatings.

Formed Container Corp., Orangeburg, N. Y., subsidiary of **Phillips Petroleum Co.,** opened a West Coast office at San Francisco, Calif., headed by **Kenneth Millhiser. Robert K. McGinnis** joined the Chicago, Ill. office sales force. FCC manufactures rigid plastic formed containers and cover materials and designs; builds and installs fully automatic packaging lines.

Kamweld Products Co. is the new name of **Kamlar Products Co.,** Norwood, Mass., mfr. of welding equipment and high-speed tools for thermoplastics. **Stanley J. Kaminsky** remains pres.; **James P. O'Connor** is sales mgr.

Sheffield Plastics Inc., Sheffield, Mass.: **Bernard W. Brooks** elected pres. and board member. **John B. Orr** appointed dir. of newly-formed R & D Div.

Antares Instruments Inc., mfr. of pantograph millers, moved its factory from Woodside, N. Y. to Route 22, Palling, N. Y., and its offices to the Phoenix-Chatham Bldg., Long Island City, N. Y.

Tri-Point Industries Inc., Albertson, N. Y., opened a new plant at 81 Venturi Ave., Warwick, R. I., for manufacture of Teflon insulating tape and film for use in wire and cable industry. **William Rawden,** v-p, heads the new plant operation. **Lester Beers** is in charge of mfg.

Shawinigan Resins Corp., Springfield, Mass.: **Dr. James A. Snelgrove** appointed research section leader for surface coatings and building products applications; **Bernard M. Brill** named group leader, building products, and **Peter M. Draghetti,** group leader adhesives. **Dr. Donald M. Gardner** appointed group leader, exploratory research in physical chemistry and polymerization methods. **Joseph G. Martins** named group leader for research on polyvinyl butyral and polyvinyl formal.

Irving Ash and **Bruce E. Porter** appointed to newly-created post of dist. sales mgr. in New Jersey and Cleveland, Ohio, respectively.

Pittsburgh Plate Glass Co.: Charles G. Brown appointed Eastern dist. sales mgr.—plastics, with headquarters in Philadelphia, Pa.; and **John L. Dayton,** dist. sales mgr.—plastics in the Chicago, Ill. branch.

C. E. Wilson appointed v-p and gen. mgr. of **Pacific Moulded Products Co.,** Los Angeles, Calif.

John K. Whittaker named pres. of **Modiglass Fibers Inc.,** subsidiary of **Reichhold Chemicals Inc.** Modiglass, located in Bremen, Ohio, manufactures glass fibers and fibrous glass mat for RP and other industries.

Larry B. Parsons named asst. operations supt. at **AviSun Corp.'s** new 100 million lb./yr. polypropylene plant at New Castle, Del.

Howard T. Cusic elected pres. and chief exec. officer, **U. S. Polymeric Chemicals Inc.,** succeeding **Maarten W. Oudegeest,** who became chrmn. of the board. U. S. Polymeric Chemicals Inc. specializes in impregnating various fibrous materials with chemical resins for use in laminating and molding.

Robert C. Appleby elected pres. of **Harry Davies Molding Co.,** Chicago, Ill. producer of proprietary molded parts for the electronic and appliance industries.

Werner A. H. Eckhardt named mgr. of **Deutsche Oerlikon-Plastic GMBH,** Munich, Germany mfr. of extruders and extruder systems.

Thomas B. Howley named stearates mgr. for **Nuodex Products Div., Heyden Newport Chemical Corp.** He will direct sales of Nuodex Stearates, used as resin stabilizers, mold lubricants, and paper coating additives, etc.

George L. Fearnley Jr. named mgr. of **The Kordite Co.'s** new plastics mfg. facilities in Tyler, Texas. **Melvin S. Cagen** succeeds Mr. Fearnley as plant manager at Macedon, N. Y.

Sheldon M. Rose appointed sales agent in upstate N. Y. area for **Mol-Rez Div.'s** line of industrial polyester resins and related materials. Mol-Rez is a subsidiary of **American Petrochemical Corp.**

C. J. Hussey appointed end-use coordinator in the Plastics Div. sales department, **Koppers Co., Inc.,** Pittsburgh, Pa.

Corrections

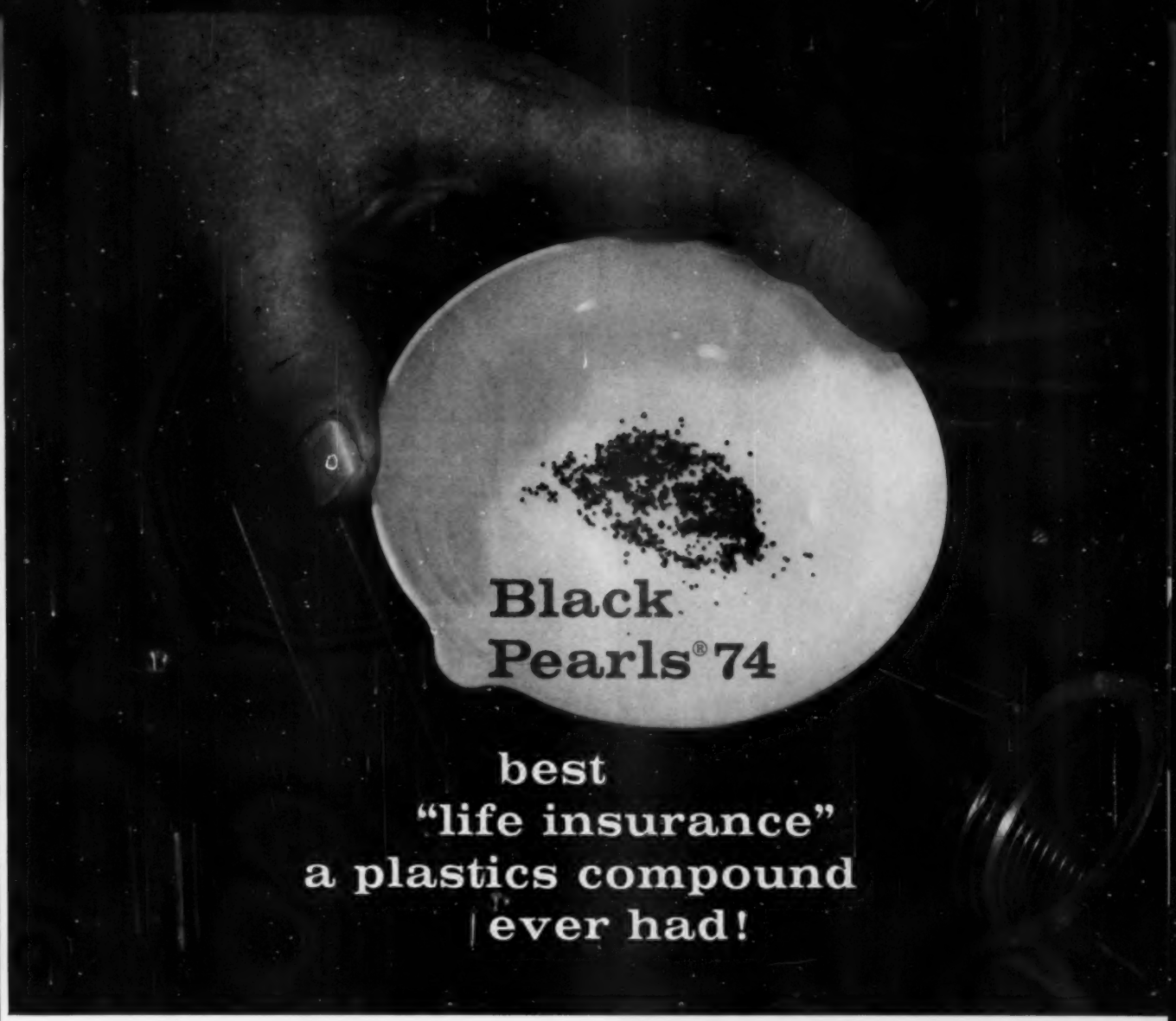
"Foaming agents for plastics" (Modern Plastics Encyclopedia Issue for 1962, p. 414): The current price per pound given for Kempore R-125 is in error, owing to an inadvertent transposition in the figures. The correct price for this material should read $1.92/lb.

"How to hot hob beryllium copper" (MPI, July 1961, p. 101 ff.): Photographs for this article were supplied by Joseph Schneider, Sepco, 2326 Sawtelle Rd., Los Angeles 64, Calif.

"Shrinkage of glass-reinforced polyesters" (MPI, Feb. 1961, p. 124): Data for Table II should read:

Monomer	*Shrinkage of polyester*
	%
Diallyl phthalate	11.8
Vinyltoluene	12.5
Styrene	15
Methyl methacrylate	21

These data were obtained by using the specific gravities (SG) of the monomers and polymers (ASTM D792-50) and were computed as follows: % Shrinkage = SG of polymer-SG of monomer × 100/SG of polymer.



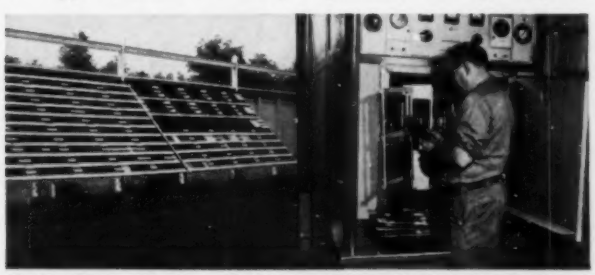
best "life insurance" a plastics compound ever had!

It takes the superfine particles of Black Pearls 74 to give plastics compounds faced with aging and weathering problems the best life insurance you can buy. Here's why:

Sunlight makes unprotected compounds brittle with age, but when Black Pearls 74 is well dispersed in plastics, the compounds retain their original degree of flexibility. At low concentrations, Black Pearls 74 gives superior weathering protection and durability, despite constant exposure to weathering from ultraviolet rays and thermal oxidation.

Black Pearls 74 has been thoroughly tested in the laboratory, and proved superior in hundreds of different commercial applications. It is readily dispersible, insuring complete utilization of its ultraviolet absorption properties. Manufactured to highest quality standards throughout every step of manufacture, it carries the Cabot guarantee of absolute product uniformity.

Ask your nearest Cabot representative to supply complete details about Black Pearls 74, and the improvements it can impart to your compounds. He will help you to evaluate the possibilities for use of Black Pearls 74 to add life insurance beyond that which you may now be expecting from your compounds. For complete information on Black Pearls 74, please use the coupon below.



Best by Test — Studies conducted on special outdoor test fences (1) and Weather-Ometer* tests (r) show compounds containing Black Pearls 74 stand up best under aging and weathering. All Cabot blacks are subjected to the most extensive, thoroughgoing test programs in the industry.

*a registered trademark of Atlas Electric Devices Co.

Special Blacks Division

CABOT CORPORATION

125 High Street, Boston 10, Mass.

Please send me
- ☐ a free sample and information on Black Pearls 74
- ☐ the booklet, "Carbon Blacks for Paints"

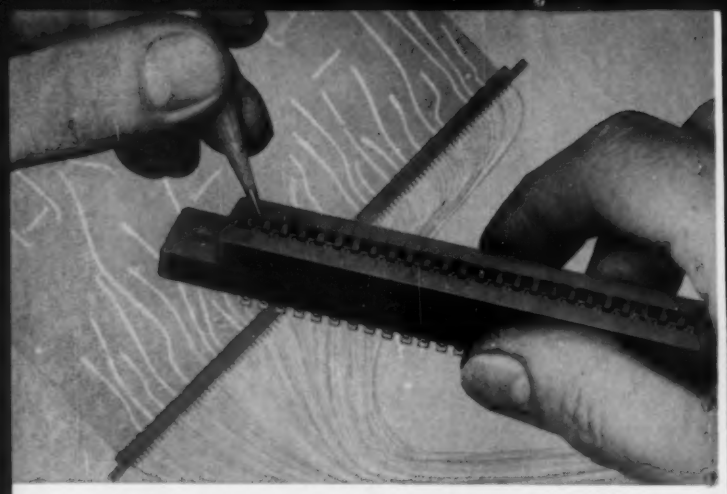
NAME.....

TITLE.....

COMPANY.....

ADDRESS.....

ALLYL RESINS & MONOMERS specialties of FMC



PRINTED-CIRCUIT CONNECTOR molded of DAPON® M contains hundreds of terminals. Seventeen-inch connector operates at 450°F . . . stays straight and true owing to dimensional stability of the resin.

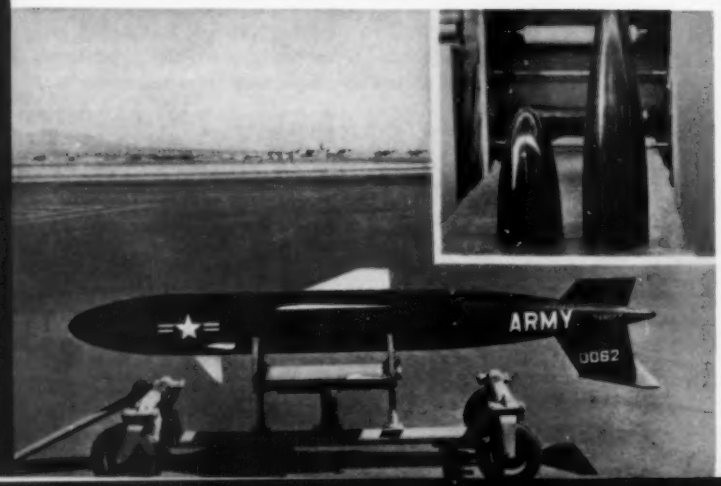
Molding compounds and laminates made from DAPON (diallyl phthalate) and DAPON M (diallyl isophthalate) prepolymers offer a superb combination of electrical, thermal and mechanical properties. The resins provide:

- Excellent electricals, which remain virtually unchanged by high temperature and humidity.
- High heat resistance—350-400°F for DAPON and 400-450°F for DAPON M.
- High strength, hardness, dimensional stability, and resistance to chemicals, moisture, abrasion.
- Easy molding and fabrication; good flow with fast cure cycles.

Molding of these thermosets is aided by the materials' good hot strength. No volatiles are given off during molding, and negligible postmold shrinkage means no cracking around metallic inserts. *Laminates* made with DAPON resins have excellent handling properties and improved strengths over other laminating resins—especially hot flex strength.

DAPON

NOSE CONE and aft end of supersonic target drone are made of a DAPON® prepreg laminate. The tough components have high strength-to-weight ratio . . withstand aerodynamic heating.



An Invitation

For more information on FMC allylics, write for the following literature:

1. "DAPON MOLDING MATERIALS"
   Brochure covers properties, end-uses, effect of various fillers, molding. (Names of compounders using DAPON resins are included.)
2. "DAPONITE LAMINATING GUIDE"
   Brochure covers DAPONITE fabricating materials, production equipment, laminating processes, properties of laminates.
3. MONOMER TECHNICAL BULLETINS
   Please specify your interests—general, polyester, catalyst carrier.

HIGH-PERFORMANCE SURFACES can be laminated to both low-cost core stocks and high-quality veneers using DAPONITE papers. Clear and wood-patterned papers are shown.

Protect and decorate wood surfaces by the DAPONITE method, using clear or decorative papers impregnated with DAPON resin. DAPONITE can be laminated directly to almost all core materials, including: particle board, lumber core, chipboard, hardboard, plywood, asbestos-cement, paperboard. DAPONITE papers actually become an integral part of the core! The finish is tough, permanent, beautiful! Surfaces resist stains, heat, moisture, abrasion, cigarettes.

DAPONITE plastic laminates can be produced economically even by small plants. Pressures as low as 100 to 250 psi are used, so there is no danger of crushing core stock. And with cure requirements as low as 300°F, simple presses can be used to make top-quality panels. No gluing is necessary. Conventional woodworking machines may be used to fabricate handsome furniture from DAPONITE panels.

DAPONITE

CONFERENCE TABLE designed by Jens Risom has a DAPONITE® surface which protects the walnut-veneered top and brings out the beauty of the grain. Table is 14 feet long.

THE USE OF DAP MONOMER as a catalyst extender in catalyst injection spraying of polyester resins can provide vastly improved handling characteristics. The low volatility and high flash point of the monomer provide low odor and reduce fire hazards. DAP completely polymerizes in the resin system, reducing the possibility of solvent entrapment.

FMC markets a number of allylic monomers, of which DAP (diallyl phthalate) and DAIP (diallyl isophthalate) are the most widely used. These are especially valuable in polyester systems as cross-linking agents and comonomers. They become an integral part of the system and produce no volatiles during production. DAP also lends controlled tackiness to polyester prepregs.

Unlike styrene, DAP monomer requires no special measures for storage for it has very low volatility and a high flash point. It has long shelf life—will not spontaneously crosslink during storage. DAP monomer is also useful as a polymerizable, non-volatile catalyst extender for spray molding. Health and fire hazards are considerably reduced when catalysts are handled in DAP solutions. Catalyst solution stability is excellent.

OTHER FMC ALLYL MONOMERS: DAC (diallyl chlorendate), DAM (diallyl maleate), DAA (diallyl adipate).

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EMPLOYMENT • BUSINESS OPPORTUNITIES • USED OR RESALE EQUIPMENT

Machinery and Equipment For Sale

FOR SALE—(1)—12" Hale Pellitizer by Farrel Birmingham, Serial #45797, less main drive motor, with 10 H. P. U. S. Varidrive for side discharge pelletizing head, with new feed screw. This machine has been used about 1½ years. (2)—Cumberland 28" Model 40000 Ratchet Tooth Dicers. Twelve seat rotor. 220/440V, 60C., 30 H. P. motor and V-belt drive to give 2000 R. P. M. capacity is 220 feet per minute input x 28" wide sheet, when equipped with ½" ratchet tooth knives for ¼" cut, and dice size of ¼" x ⅛". One new set of extra knives. These machines are unused, having been run less than one hour on test. (1)—Thompson Broach Grinder, 6" x 48". Serial #E4311, 1½" H. P. grinder head. This machine is in very good condition and is equipped to grind dicer knives above. Write, call Uvalde Rock Asphalt Co., Box 4527, Houston 13, Tex. Fairfax 3-4351.

FOR SALE — 3"x8" Thropp Lab. Mill. Stokes Model 294 Preform Press. Electric Extruders. 1" N.R.M. 2" National Erie 6" Royal and 6" National Erie. Model R. Scott Tester. 215 cu. ft. S/S Blender Jacketed. Keith Machinery Corp., 73-15th Street, Brooklyn, N.Y. Sterling 8-5502.

FOR SALE—Baker-Perkins #16-UUEM. 150 gal. jacketed dispersion mixer, 150 HP XP drive, Vaulted cover; 100 gal. Baker-Perkins T347SS jacketed dispersion blade mixer; Baker-Perkins 200 gal. jacketed sigma-blade mixers; 200 gal. and 500 gal. stainless jacketed reactors; 1350 gal. T347 stainless jacketed resin kettle; American 42" x 120" dbl. drum dryer. ASME code, stainless trim; 2600 gal. T316 stainless pressure tanks, coils, dished heads; 1800 gal. T316SS jacketed and agit. resin kettle; 800 sq. ft. T316SS shell and tube heat exchangers; Baker-Perkins #15-UUMM, 100 gal. jktd. dispersion blade mixer, 100 HP; Worthington 70 cu. ft. rotary blender; we pay cash—top dollar—for surplus equipment. Perry, 1429 N. 6th St., Phila. 22, Pa.

FOR SALE—(1)—Intensive Mixer, same size #9, Farrel 60" Mill same as new, water cooled boxes; Baker-Perkins 100 gal. Mixer. Brewster Rubber Machinery Company, 349 E. Exchange St., Akron 4, Ohio, FRanklin 6-2911.

FOR SALE — Two Farrel-Birmingham Mills. One 84" x 26" and One 60" x 22". Reply Box 7019, Modern Plastics.

FOR SALE—Fiber Glass 52" Preformer. Fiber Glass Ovens. Turner Roving Cutter. 500 ton W-S hobbing press. 500 ton Utility five 48"x30" platens. Four 300 ton Molding Presses various makes. HPM 200 ton downstroke. Watson Stillman 240 ton, ten 24"x56" platens. W & W 200 ton, 24"x 42". Stokes Standard 50 ton semi-automatic. D&B 150 ton, 25"x25". French Oil 120 ton self-contained. 120 ton upstroke, 29"x21". 50 ton Birdsboro 24"x20" Stokes 15 ton automatics. Hydraulic pumps and accumulators. MPM 3½" wire covering Extruder. New ¾" plastic extruder. Other sizes to 6". Banbury #3 Mixer. Seco 6"x 12" 2-roll Mills and Calenders. Farrel & Thropp 40" & 48". Other sizes to 60". 60" Spreader Heads with XP motors. Despatch electric heated ovens and other types. New ¾ oz. Bench Model Injection Machines. Van Dorn 1 and 2 oz. Other sizes up to 100 oz. Baker-Perkins and Day jacketed Mixers. Taylor-Stiles Pelletizer, 3 HP. Plastic Grinders. Stokes & Colton Preform Machines. Partial listings. Send for Bulletin #192. We buy your surplus machinery. Stein Equipment Co., 107-8th St., Bklyn 15, N.Y. ST 8-1944.

FOR SALE — 2 Large Votators 4"x48", 1 Small Votator 3"x12", 1 550-440 Transformer, 1 Campbell Cushion Cutter, 1 Ammonia Compressor, Frick, 6x6, 1 7½-HP Air Conditioner, Frick. Reply Box 7005, Modern Plastics.

HIGH FREQUENCY HEAT GENERATORS—one thermex 7. K. W., 19.1 MC, grid size 14" x 20". One thermex 15 K. W., 13.7 MC, grid size 23" x 26". All units complete and for operation on 220 Volt, 60 Cycle, 3 phase. Good Condition. Standco Supply Co., 2701 Clinton Dr., Houston, Texas.

FOR SALE—Van Dorn Model H-200 One Oz. Injecting, Hydraulic machine. 2 H.P. 220 volt A.C. 60 cycle motor single phase. Hand operated. Apply A. G. Harney, 4360 Furman Ave., Bronx 66, N.Y. Phone FA 5-8170. Price $2,000.00 cash. Machine at Lake Peekskill, N. Y.

FOR SALE—(1)—Thropp 2-Roll Mill 18" x 50", 6" x 12", 2" x 6", complete with motors; (2)—Cumberland #18 and #½ Granulators with motors; (3) — Baker Perkins 50, 100 and 150 gal. Sigma blade jacketed Mixers; (1)—P-K 1 cu. ft. 304 SS "V" Blender; (3)—Mikro Pulverizers, Bantam, 1SH and 1SI; (5)—Stokes Preform Presses, models R, T, DD2, DDS2 and D4; partial listing, send for details. Brill Equipment Company, 35-55 Jabez St., Newark 5, N. J. Tel: MArket 3-7420.

FOR SALE—(1)—2" Hartig electrically heated plastics extruder; (2)—300 ton Dunning & Boschert compression molding presses; (1)—Readco 190 cu. ft. stainless steel jacketed ribbon blender; (1)—MPM 2½" electrically heated plastics extruder; (3)—Ball & Jewell graduators 7½, 10, 15 HP. Chemical & Process Machinery Corp., 52 9th Street, Brooklyn 15, N.Y. HY 9-7200.

FOR SALE—Stokes Molding Presses. 50 ton, model 741. Full Automatic. Also Stokes Standard 50 ton, Semi Automatic. Blow Molding Set Up—2" Kato, one year old, complete with all controls and blow molding equipment. With variable speed drive. 2½" Sterling, long barrel, used less than one month. With complete blow molding set up and all controls. Injection Molding Machines—4 oz. Harvey, 8 oz. Reed Prentice, 12 oz. DeMattia, 12 oz. Reed Prentice. All in stock. Immediate Delivery. Stokes Model R Single punch tablet press, with vari speed drive. 6" Hartig Extruder, 16.5:1 Electrically Heated Barrel. Complete with all controls and motor drive. 1" NRM Lab Extruder, complete with drive and controls. Scrap Grinders—1½ HP up to 50 HP available. We have a full line of Laminating Presses, Molding Presses, Mills, Calenders, Extruders, Injection Molders, Scrap Grinders, Coating Equipment and other accessories for the Plastic Industry. We will finance. Johnson Machinery Co., 90 Elizabeth Ave., Elizabeth, N.J. EL 5-2300.

LIQUIDATION PRICES ON Good Rebuilt Rubber and Plastic Equipment. F-B Banbury Mixers #00, #11. Unused 2 Roll Mills, 14"x30". F-B Mills, 18"x54", 22"x60". 3 Roll Calendars, 6"x18", 22"x60". Hartig 4½" and 6" Electr. Extruders. NRM 1½" and 2½" Electr. Extruders. NRM Oil Heated 2½" Extruder. Welding Engrs., 2" Twin Screw Extrd. B. & J. Rotary Cutters and Abbe. Stokes 150 ton Molding Presses. Hydraulic Presses 7 to 1000 ton. Preform Presses, Autoclaves, Ball Mills, Blenders, Dryers. First Machinery Corp. 209-289 Tenth St., Bklyn. 15, N.Y. ST 8-4672; Cable: "Effemcy".

Materials For Sale

FOR SALE—Large quantity general purpose polystyrene powder, virgin material, original containers. Write Box 7013, Modern Plastics.

FOR SALE—Available for immediate delivery, 500,000 pounds hercules K-100 virgin ethyl cellulose flake at substantial savings. We will compound to any specified formulation and color. Write for quotation to Box 7018, Modern Plastics.

Materials Wanted

WANTED—Flocked high impact styrene in gauges 7½ mil. to 40 mil. in basic colors (pastels) OR will negotiate flocking process under license or royalty basis for frgn. market. Write Reale International Corp., 1964 W. 10th St., Bklyn 23, N. Y.

GET THE TOP MONEY FOR PLASTIC SCRAP—Now paying top prices for all thermoplastic scrap. Wanted: polystyrene cellulose, acetate, vinyl, polyethylene, butyrate, acrylic nylon. All types and forms including rejects and obsolete molding powders. Fast action wherever you are located. Write, Wire, Today! Reply Box 7022, Modern Plastics.

PLASTIC SCRAP WANTED—Clear Acetate and Butyrate sheet scrap, cast acrylic, acrylic molding powder, styrenes, etc. We pay top dollar for your plastic scrap and surplus molding powders. Write, wire or phone collect—TL 3-3111—Philip Shuman & Sons, Inc., 571 Howard Street, Buffalo, New York.

Help Wanted

FLORIDA LOCATION: Plant Foreman and Production Engineer, (2 positions) wanted with plenty mechanical know-how in sheet extrusion and vacuum forming. If you have ability, dynamic leadership, and want to earn a good living and have fun doing it, contact us in confidence. We are a publicly owned small company; stock has doubled in nine months. Ownership possibilities through performance. Reply Box 7028, Modern Plastics. Submit background and expected salary.

FACTORY SUPERINTENDENT — Completely capable. 150,000 sq. ft. plant. From Maintenance to top supervisory exp. Must be strong & aggressive. Has Banbury operations, wire drawing mills and large number of plastic extrusion machines. North New Jersey. Send Resume including salary requirements. Reply Box 7025, Modern Plastics.

WANTED — INDUSTRIAL PLASTICS SALESMAN for injection molding and blow molding sales. Established company. Must be experienced. Fair salary or commission to be discussed. Reply Box 7023, Modern Plastics.

Needed by one of U. S. largest plastic injection molders. **PLANT SUPERINTENDENT** with engineering background and practical experience in injection molding as well as pressure forming. **SALES MANAGER** with knowledge of pressure and vacuum forming sales and distribution. Substantial Salary, incentive plan on increased business and part of net profits—only qualified individuals who are looking for a stable and profitable future need apply. Complete resume and references to: Box 7015, Modern Plastics.

MFRS' REPS.—Leading producer of color concentrates for the plastic industry seeks additional representation for exclusive sales territories. Exclusive products backed by top merchandising program will yield lucrative income to aggressive personnel with established contacts. Advise territory covered, present principals and products. Pleasant Industrial Chemicals, Inc., 270 Lincoln Blvd., Middlesex, N. J.

WANTED—PRODUCTION SUPERVISOR —Leading plastics concern has opening for experienced Extrusion Engineer. College graduate preferred. Excellent opportunities. Send complete resume to Box 7011, Modern Plastics.

PLEXIGLAS SALES—Technical sales openings are available for field positions in Plastics. Candidate should have Chemical Engineering or Mechanical Engineering Degree, from two to five years industrial sales experience and a continuing interest in technical sales. A non-technical degree may also provide necessary requisites if some technical courses have been included and the applicant has a strong mechanical aptitude. Training period in the Philadelphia area. Salary plus expenses, with company car provided. Send full details to: C. S. Betts, Technical Employment, Rohm & Haas Co., 222 W. Washington Square, Philadelphia 5, Pa.

WANTED—Representative for plastic injection and compression molding firm to handle sales on straight commission basis in Chicago area. Reply Box 7010, Modern Plastics.

(Continued on page 286)

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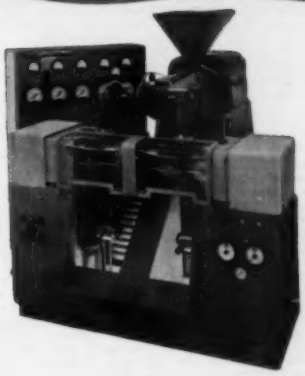

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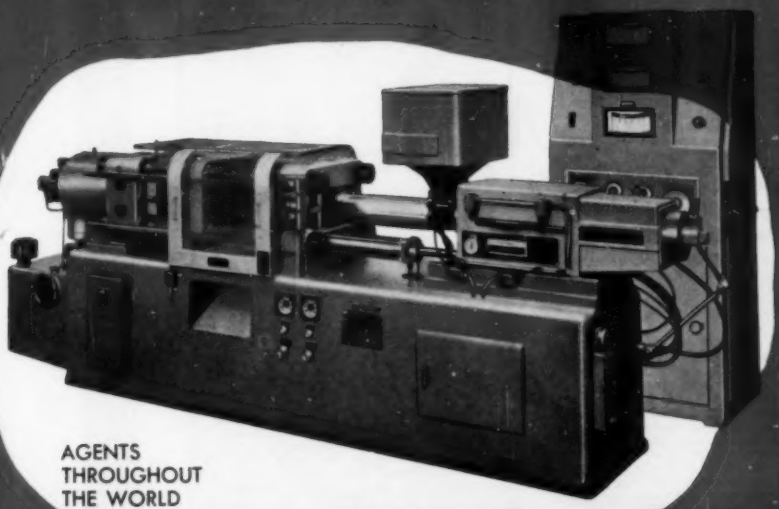

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(Continued from page 284)

PLASTICS EXTRUDER ENGINEER—Nationally known manufacturer has opportunity for Mechanical or Chemical Engineer graduate for research and pilot plant operations in Chicago area research center. Working knowledge of thermo plastic, extrusion, laminating and vacuum forming is very much desired. Excellent opportunity for qualified man. Reply in confidence giving age, education, experience and salary desired. Reply Box 7012, Modern Plastics.

SALES ENGINEERS—Prominent manufacturer of fiber glass products needs men with experience and proven sales ability in the reinforced plastics field. Good salary, substantial fringe benefits and opportunity for advancement in a growth industry. Written resume with full information required prior to personal interview. All replies will be treated in strictest confidence. Box 7004, Modern Plastics.

UNUSUAL OPPORTUNITY—For chemist experienced in compounding and processing P.V.C. suspension and dispersion resins. Excellent fringe benefits. Send photo, pertinent information and starting salary requirements. Vinyl Corp. of America, 600 N. Irwin St. Dayton 3, Ohio.

MOLDING MACHINE SALES ENGINEERS—Opening in New York City area for injection molding machine sales engineers. Territory is presently being serviced by agents. Company undergoing rapid expansion program. Currently offers complete line of machines nationally from 6 oz. to 50 oz., plunger type, 2nd stage injectors, and reciprocating screw type. Must have successful sales record in plastics industry with present earnings in excess of $12,000. Compensation based on salary plus commission. Reply A. Nickerson, V.P., Lombard Governor Corporation, Main Street, Ashland, Mass.

SALES ENGINEERS—Standard mold set manufacturer requires additional representatives in several areas. Applicants must have proven selling abilities as well as moldmaking background. Protected territories. Write stating experience and qualifications, National Tool & Manufacturing Company, Kenilworth, N. J.

MANUFACTURERS REPS WANTED. To solicit OEM accounts on straight commission basis. We specialize in custom thermoforming and fabricating windshields, housing, containers, etc. Desire representation in Atlanta, Kansas City, West Coast and New York trade areas. Men with plastic forming knowledge required. Give complete resume, territory covered and references. Write Texstar Plastics, Division of The Texstar Corp., Box 1440, Fort Worth, Texas. Attn: W. I. Spitler, President.

CONSULTANTS WANTED—For all types of plastics operations from basic research to fabrication techniques. Thermoplastics, thermosets, reinforced plastics foams. Both in U. S. and abroad. Send for complete information. Box 7009, Modern Plastics.

SALESMEN WANTED—Company located in the East, licensed to use the Shaw Process for making cast molds in Beryllium Copper or Steel offers excellent opportunity to Salesmen with following in the Mold Making, Plastics, Die-Casting industries or other allied fields. Various territories available. Send resume stating full qualifications and experience. Reply Box 7007, Modern Plastics.

TOOL DESIGNER—Growth opportunity with well established proprietary molder for man with heavy experience in plastic injection mold design. Knowledge of modern molding machines desirable. Send resume, include salary required to Sterling Plastics Co., 1140 Commerce Ave., Union, N. J.

WANTED—AAA1 injection molding firm located in Chicago, Illinois has excellent positions open for men with proven record of supervisory experience such as: Maintenance Superintendent With knowledge of building heating, air conditioning, lighting, hydraulics and trouble shooting. Finishing Superintendent and Finishing Foreman Experienced in spraying, hot stamping, buffing and vacuum plating (metalizing). Vacuum Metalizing Supervisor With full knowledge of operations. Salary open on above positions. Excellent company benefits and good working conditions. Steady employment. Apply in person or send resume to John O. Burr, Pers. Mgr., G. Felsenthal & Sons, Inc., 3500 N. Kedzie Ave., Chicago 18, Ill.

WANTED—Experienced vinyl profile die maker and extruder operator. Capable of handling shape from print to finished product. Houston, Texas location. Excellent opportunity for right man. Reply Plastic Dept., Box 7422, Houston 8, Texas.

WANTED—TOOL DESIGNER for Compression, Transfer and Injection molds. Must have had several years experience, and at least two years of college. Excellent pay and working conditions. Located in Western Pennsylvania. Reply Box 7029, Modern Plastics.

RESEARCH MANAGER—Creative research engineering manager, sales oriented, and capable of organizing and operating a research and development department for a major company in the field of corrugated fibreboard shipping containers, plastics, board combinations, and other related products. Excellent opportunity for man who can follow product from initiation of idea to marketing phase. Must be able to get things done. Desire man 35 to 45 with MS or PhD and a proven record of accomplishments. Salary commensurate with ability. Reply giving full details regarding age, education, experience, and salary requirements. Address replies to Box 7003, Modern Plastics.

PLASTIC SALES ENGINEER—Immediate opening for Chemical Engineer or Chemist experienced in selling and servicing urea/melamine molding compounds. Strong sales background preferred but applicants with solid production experience in manufacture and use of thermoset materials will be considered. Interested applicants should reply, in confidence, by resume to—Recruitment Manager, American Viscose Corp., 1617 Pennsylvania Boulevard, Philadelphia 3, Pa.

PRODUCT DEVELOPMENT—PLASTICS PROJECT LEADER—Major Oil Company with diversification program needs project leader for new Plastics Development Section in R & D. Must be capable of initiating important new projects and of making broad evaluations of new materials compared to competitive plastics. Applicants should have strong background in plastics and fabrication processes, with 3 to 10 years' experience in product development or application research. Exciting opportunity to contribute to the success of an important new activity. East Coast location. Send resume and salary requirements to: S-44, P. O. Box 2066, Philadelphia 3, Pa.

EXTRUSION ENGINEER — Opening available in new extrusion laboratory for an engineer capable of planning and operating a program on extrusion of polycarbonate resins. This headquarters position combines laboratory work and field service with customers. Technical degree with strong background of experience in extrusion required. In reply please give details of education, experience, and earnings. —An Equal Opportunity Employer— Mail replies to: Mr. R. J. Thompson Manager—Polycarbonate Market Development, Chemical Materials Department, General Electric Company, One Plastics Ave., Pittsfield, Mass.

Situations Wanted

DAYTON OHIO AGENT for well known Injection-Compression molder wants allied lines. Will accept only financially sound, aggressive companies. Service Associates, Box 2034, Dayton 29, Ohio.

REINFORCED PLASTICS Managerial Talent. Presently employed successful profit-producer seeks change. Combination of early diversified scientific and technical background followed by business management and operating experience at middle and top levels in both small and large companies. Demonstrated creativity, energetic aggressive approach, wide scope of abilities including executive sales, mature business acumen, solid technical competence and originality. Reply Box 7008, Modern Plastics.

PLASTICS SALES ENGINEERING—Highly successful, 20 years record of selling top industrial accounts for custom molder in New York Metropolitan area. Strong background in design, development and production of molded parts. Reply Box 7024, Modern Plastics.

MODEL MAKER, SCULPTOR—Working Designer seeks responsible, challenging position model and development work for plastic firm. Have expensive design and technical experience for blow molding, vacuum forming, injection molding for toys, housewares, etc. Reply Box 7027, Modern Plastics.

SPLITTING MACHINE CONSULTANT—desires position of responsibility with a plastics organization within an area of 50 miles of Boston, Mass. Will welcome replies from other areas. Capable of assembly, set-up, operation and maintenance of splitting machines. Long experience and excellent references. Reply Box 7026, Modern Plastics.

BLOW MOLDING CONSULTANT—B.S. in M.E., B.S. in B.A., M.B.A., 35 years old, 15 years experience. Will set up a blow molding operation, recommend machinery, install it, design and supply utilities, design and procure molds and finishing equipment, train personnel. References. Box 7021, Modern Plastics.

MANUFACTURERS REPRESENTATIVE AVAILABLE—experienced in Plastics. Interested in representing Injection, Compression, and Extrusion companies in the custom sales field. Territory, Northeastern Ohio and Western Pennsylvania. Coverage, O.E.M. and general industrial accounts. Box 7020, Modern Plastics.

PLANT MANAGER—10 years experience in plastics extrusion of pipe, shapes, compounding, and scrap reclaiming. Knowledge of all phases of plant management and extrusion engineering. Interested in running extrusion plant from development to production. Age: 34. BME. Prefer N.Y.-N.J. Area. Reply Box 7017, Modern Plastics.

BLOW MOLDING—Michigan Representative with an outstanding record in the plastics field wishes to represent blow molder who is technically advanced and capable of producing competitive high-production blow molded parts other than containers or bottles. We will develop markets for your products for a commission or retainer fee. Box 7016, Modern Plastics.

Business Opportunities

MAJOR BRITISH COMPANY in the synthetic resin and plastic raw material field wishes to extend its activities in two ways. The Company is prepared to use its extensive sales force and large technical service facilities for the exclusive representation of United States companies on the British market. The Company also would like to extend its range of manufacture by suitable license agreements with companies in the U. S. fitting framework of present interests. Reply Box 7014, Modern Plastics.

WANTED TO PURCHASE—Nationally known manufacturing company desires to purchase a plastic molding plant. Give plant location, size, equipment, asking price, and all other necessary information. Reply Box 7006, Modern Plastics.

HAVE YOU CANADIAN MANUFACTURING FACILITIES? Present exchange rates and customs duties make the Canadian market difficult for U.S. based chemical makers. In our factories in Montreal and Toronto we have a great variety of chemical production facilities, and our salesmen cover all of Canada. It may be greatly to your advantage to have us make your products under a licensing agreement. We will deal only with established U.S. firms, and with principals only. If interested please write H. L. Blachford, Limited. 977 Aqueduct St., Montreal 3, Canada.

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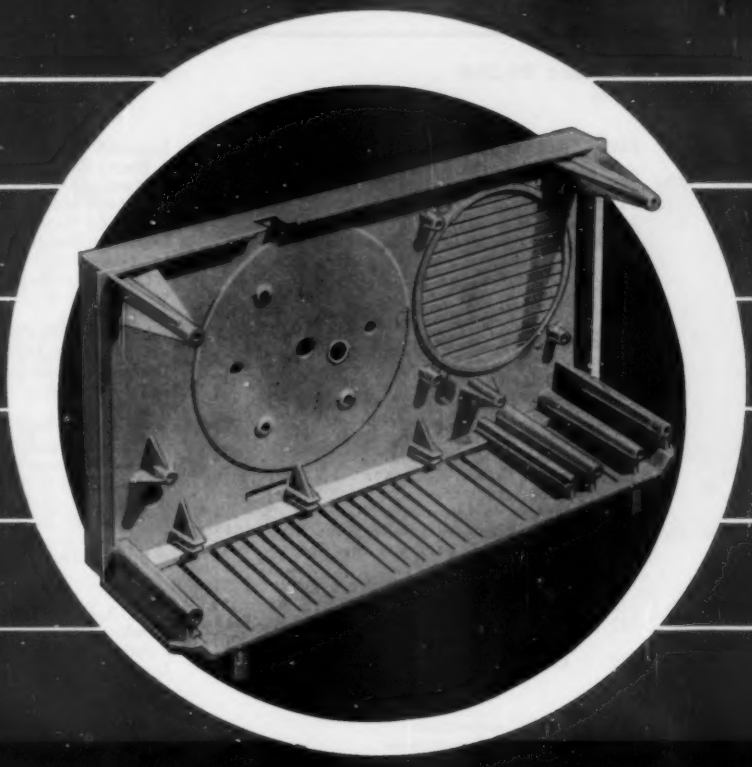

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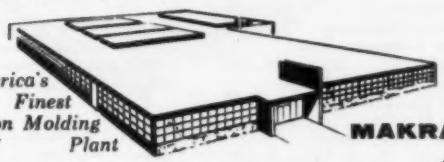

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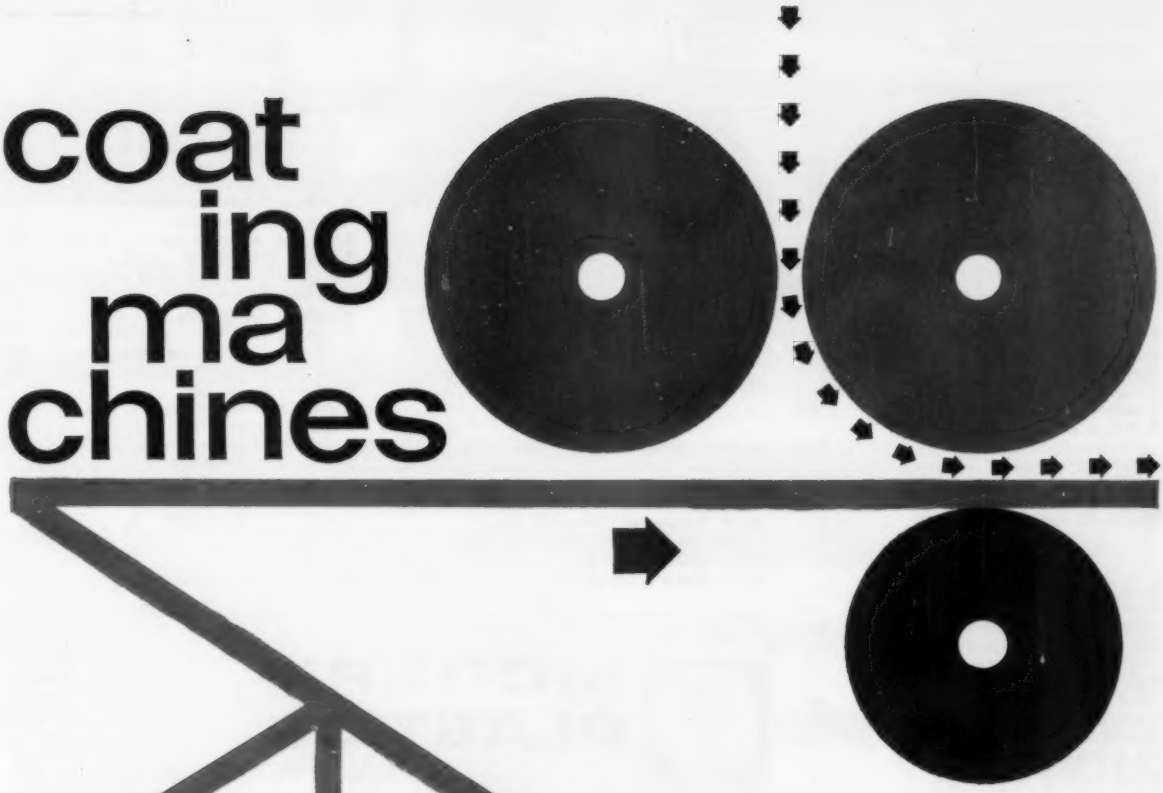

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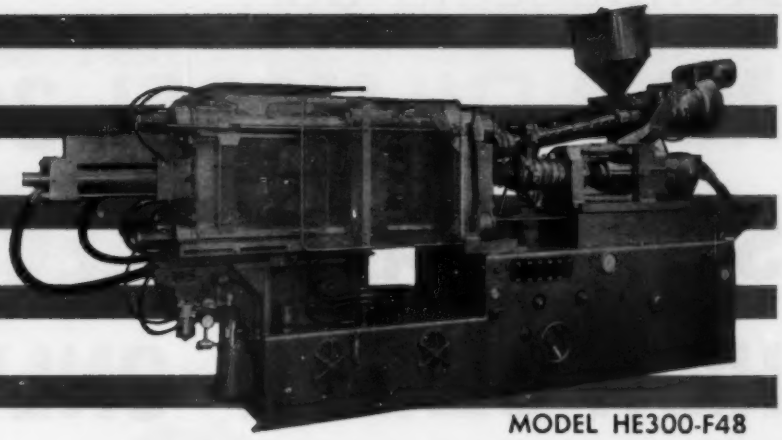

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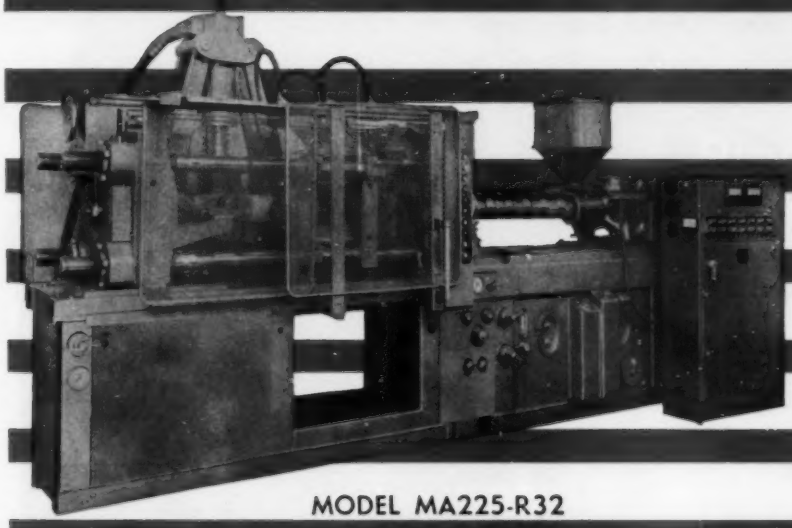

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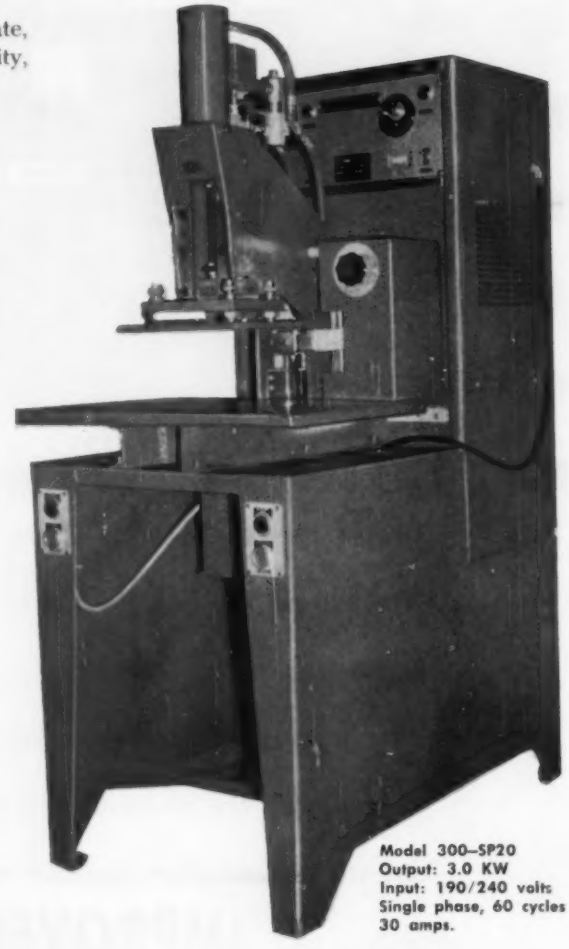

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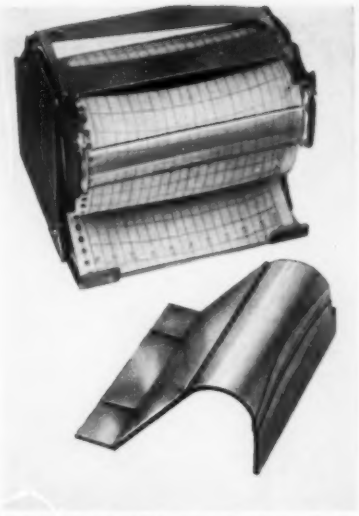

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